

REPORT ON RIVER CONTROL WORK AND INVESTIGATIONS LOWER COLORADO RIVER BASIN 1972 - 1973

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**COLORADO RIVER FRONT
WORK & LEVEE SYSTEM
DECEMBER 1974**



**UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION**

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REPORT ON
RIVER CONTROL WORK AND INVESTIGATIONS
LOWER COLORADO RIVER BASIN

CALENDAR YEARS 1972 AND 1973

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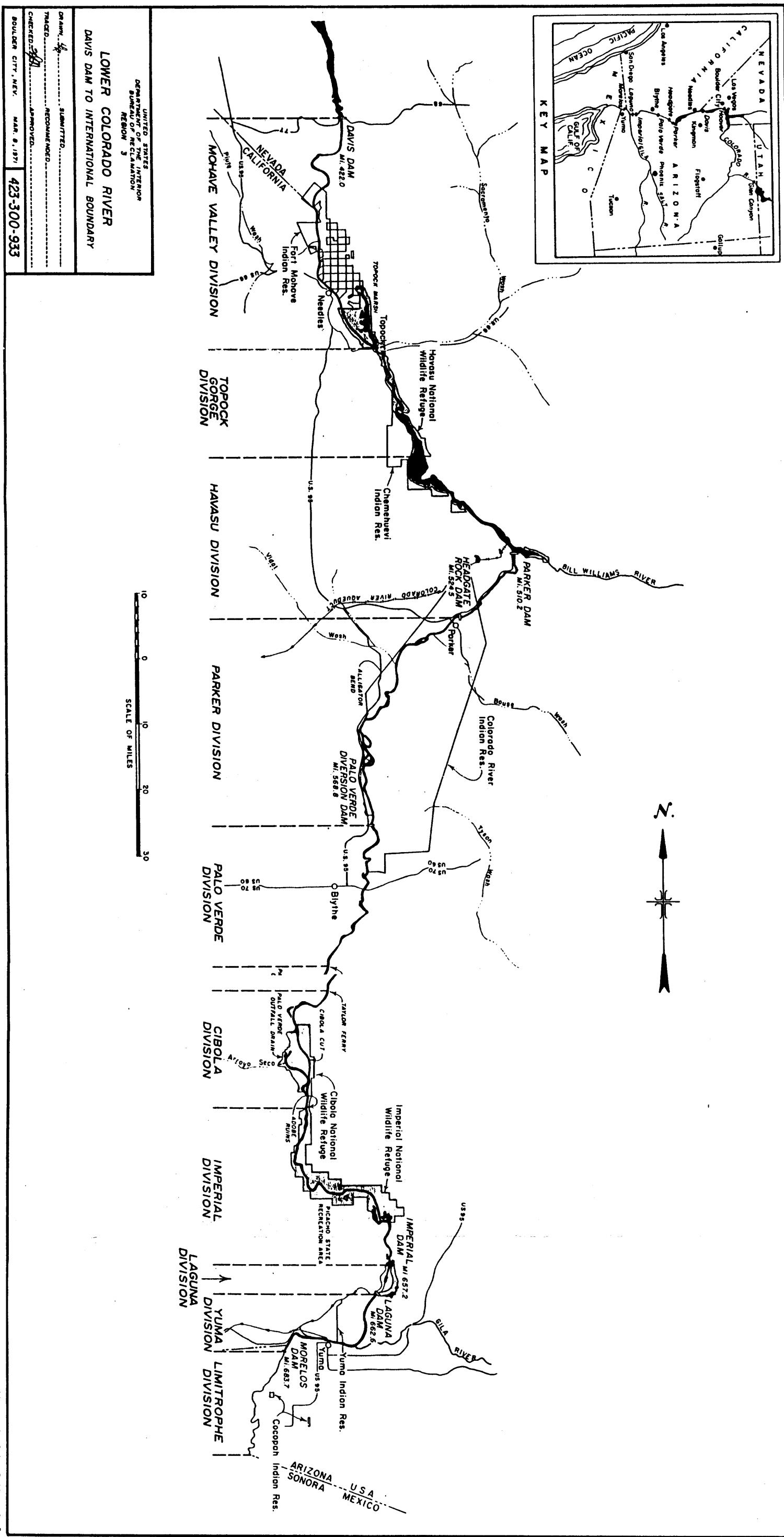
Colorado River Front Work and Levee System
Arizona, California, Nevada

December 1974

Gilbert G. Stamm, Commissioner
E. A. Lundberg, Regional Director, Lower Colorado Region
Bureau of Reclamation

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ABSTRACT

This report continues the presentation of results and data from aggradation and degradation surveys and other sediment-movement investigations on the Colorado River between Davis Dam and the International Boundary with Mexico. The studies were begun in 1935 below Hoover Dam as that structure was nearing completion. Reports covering the studies have been published periodically since that time. The present report covers the years 1972 and 1973, although considerable data for preceding years are also included to facilitate comparisons.

The report also covers the physical work being performed to stabilize and manage the river and contains selected information on the scheduling and use of river water for irrigation, domestic uses, recreation, and power production.

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I. INTRODUCTION

The completion of Hoover Dam totally changed the downstream regime of the Colorado River. Subsequent construction of Davis, Parker, Headgate Rock, Palo Verde, and Imperial Diversion Dams added to this change. The most noticeable change caused by the dams was the marked reduction in flood peaks. Also important, however, was the change in sediment characteristics. Most of the sediment carried by the river was trapped in Lake Mead, and the clear water flowing from Hoover Dam created an entirely new sediment condition downstream.

The planners and designers of Hoover Dam knew the river's characteristics would be greatly altered. In 1935, when the dam was nearing completion, a program of hydrologic measurements was begun to determine changes in river regime. That program with modifications to accommodate new structures and improved technology has continued to the present. Reports on those measurements were published by the Office of the Chief Engineer, Denver, Colorado, for the years 1935 through 1943. The Lower Colorado Region, Boulder City, Nevada, assumed responsibility for the 1944 and all subsequent reports.

As work to control the channel of the lower Colorado River was undertaken, the report was expanded to cover various aspects of that work. This report is a continuation of many of the original reports on sediment characteristics of the river. It also briefly covers

dredging and related work to physically control the river, and information on the use of river water for irrigation, domestic uses, recreation, and power production. It covers the years 1972 and 1973, although much data from preceding years are included to illustrate changes that have occurred.

II. GENERAL DESCRIPTION OF THE STUDY AREA

A. Introduction

The Colorado River rises high in the Rockies of northern Colorado, and from its source flows 1,400 miles southwest to the Gulf of California. It crosses mountain vales in Colorado, spectacular canyons in southeastern Utah and northern Arizona, including the Grand Canyon, and finally, below Lake Mead, desert alluvial valleys rimmed by barren mountain chains. Its principal tributaries are the Green, Gunnison, and San Juan Rivers in the upper basin; and the Little Colorado, Virgin, Bill Williams, and Gila Rivers in the lower basin.

In its uncontrolled condition, the Colorado River at Lees Ferry (Figure 1) is estimated to have had an average flow of 14.9 million acre-feet. ^{1/} The annual flow probably ranged from 5.6 million acre-feet to as much as 24 million acre-feet. The river also carried a tremendous amount of sediment, and ranked as one of the largest sediment-carrying rivers in the world.

The drainage basin covers about one-twelfth of the total area of the contiguous United States and includes portions of seven states. It is divided naturally into two parts: the plateau region or Upper Basin; and the desert region or Lower Basin. Lees Ferry, Arizona, 17 miles below Glen Canyon Dam and just downstream from

^{1/} Average virgin flow 1896-1966, from Hely, Allen G., Lower Colorado River Water Supply - Its Magnitude and Distribution, Geological Survey Professional Paper 486-D, 1969, p. D13.

the mouth of the Paria River, is the dividing point between the Upper and Lower Basins. The data presented in this report relate only to the Lower Basin. The Lower Basin is illustrated on three maps: the Frontispiece and Figure 2 show the river below Davis Dam; Figure 1 shows the river above Davis Dam.

B. The Lower Colorado River

From Hoover Dam to the International Boundary with Mexico, the Colorado flows south for 326 miles. This report is primarily concerned with this part of the river. Brief descriptions of the various river reaches follow:

1. Hoover Dam to Davis Dam. Before the construction of Davis Dam, the Colorado flowed through a narrow canyon for 67 miles below Hoover Dam. With the completion of Davis Dam and the filling of Lake Mohave, this reach was inundated.

2. Davis Dam to Parker Dam. For 6 miles below Davis Dam, the river is confined by cobble banks. Below this stable reach, the river enters the Mohave Valley, an ancient flood plain with a maximum width of 5 miles. Early history of the Mohave Valley shows that the river meandered from side to side across the plain. Recently, however, it has been stabilized and confined near the valley's west side. At Topock, 32 miles downstream from Big Bend, the river enters the narrow, rugged Topock Gorge and flows 17 miles to Lake Havasu, the reservoir above Parker Dam.

3. Parker Dam to Imperial Dam. Below Parker Dam the river flows 14 miles through a canyon to Headgate Rock Diversion Dam. The water surface above Headgate Rock Dam is automatically kept at a constant level, creating a stable pool.

Below Headgate Rock Diversion Dam, the river travels 100 miles through a rich agricultural valley, which in popular usage is divided into three sections: the Parker, Palo Verde, and Cibola Valleys. The river has had considerable freedom to meander through this alluvial valley. Below the Cibola Valley section, however, the river enters a relatively narrow and inaccessible 40-mile reach which ends at Imperial Dam.

4. Imperial Dam to the Mexican Border. Near Imperial Dam, the Colorado River spreads into a broad, fertile, extensively irrigated delta. Most of the river's flow is diverted at Imperial Dam.

III. DISCHARGE OF THE RIVER

With the completion of Hoover and other dams, flows of the lower Colorado River were largely controlled. Spring floods and long periods of low runoff are no longer yearly occurrences; instead, spring runoff is stored in reservoirs and released through the summer as needed downstream. An important use of the river channel is the conveyance of water, according to computed schedules, to meet downstream diversion requirements. Large floods may still occur infrequently, however, and channel capacity must be maintained to convey them safely to the Gulf of California. Minimum flows are maintained to avoid damaging the fisheries resource of the river.

A. Average Flows

Mean summer and winter flows at various gaging stations on the river are shown below. These and other gages are listed in Table 2.

| <u>Station</u> | <u>Average Flow in ft³/s</u> | |
|----------------------------------|---|---------------|
| | <u>Summer</u> | <u>Winter</u> |
| Below Davis Dam | 15,200 | 7,000 |
| Topock Bridge | 14,900 | 6,700 |
| Below Parker Dam | 13,200 | 5,400 |
| Below Palo Verde Dam | 9,600 | 3,800 |
| Adobe Ruins | 10,700 | 5,400 |
| Northerly International Boundary | 2,500 | 1,300 |

A larger mean flow at a downstream station than at one upstream generally reflects irrigation return flows to the river. A more detailed description of the overall operation of the reservoirs and river system is found in a later section covering dams and reservoirs.

B. Floodflows

Construction of large multipurpose dams on the Colorado has brought great reductions in downstream flood peaks. For example, in 1941 a maximum mean daily inflow to Lake Mead of 119,200 ft³/s was reduced to a maximum mean daily outflow of 35,500 ft³/s. Nevertheless, large flows can still occur below the dams. A levee-design flood has been adopted for use in flood-protection planning. Based on a severe but reasonable combination of hydrological and meteorological conditions occurring in the watershed, it consists of releases through the dams as well as local inflow from tributaries below the dams. Flows of the levee-design flood are as follows:

| | |
|---|----------------------------|
| Davis Dam to River Mile 443 (Piute Wash) | 50,000 ft ³ /s |
| River Mile 443 to Lake Havasu | 70,000 ft ³ /s |
| Parker Dam to Palo Verde Dam | 50,000 ft ³ /s |
| Palo Verde Dam to Taylor Ferry (R.S. 23) | 75,000 ft ³ /s |
| Taylor Ferry to Adobe Ruins | 80,000 ft ³ /s |
| Imperial Dam to Gila River | 103,500 ft ³ /s |
| Gila River to Southern International Boundary | 140,000 ft ³ /s |

IV. MEASUREMENTS OF EROSION AND SEDIMENTATION

A. River Cross Sections

A series of river cross sections was established in 1935 to be periodically surveyed so that the pattern of scour and fill could be determined. Cross sections were first established just below Hoover Dam and later extended downstream as shown below:

| | |
|--|------|
| Hoover Dam to River Section 19 | 1935 |
| River Section 19 to Searchlight Ferry | 1936 |
| Searchlight Ferry to Katherine Wash | 1937 |
| Katherine Wash to Fort Mohave | 1938 |
| Fort Mohave to Needles | 1939 |
| Needles to Lake Havasu | 1941 |
| Parker Dam to Imperial Dam | 1938 |
| Imperial Dam to International Boundary | 1940 |

Following the closure of Davis Dam, the cross sections between Hoover and Davis Dams were abandoned. Since 1971, cross section data have been gathered at 220 river cross sections and distributed as follows:

| <u>River Reach</u> | <u>Distance in Miles</u> | <u>Number of Sections</u> |
|--|------------------------------|-------------------------------|
| Davis Dam to Lake Havasu | 59 | 86 |
| Parker Dam to Imperial Dam | 147 | 91 |
| Imperial Dam to International Boundary | 46 | 43 |

See Figure 2 for general location of selected cross sections.

The cross sections between Davis Dam and Lake Havasu begin with River Section No. 28 (R.S. 28) immediately below Davis Dam and progress through R.S. 43.99 in Lake Havasu. Additional cross sections (not shown in Figure 2) were later established among the existing sections between Topock and Davis Dam. They are numbered by miles and start with Mile 0.2 at Topock Bridge and progress upstream to Mile 38.3 near Davis Dam.

Between Parker and Imperial Dams, cross section numbering progresses upstream from R.S. 1 immediately above Imperial Dam to R.S. 41 just downstream of Parker Dam. Care should be taken not to confuse the cross section numbers in this reach with those in the Davis Dam to Lake Havasu reach.

Below Imperial Dam, cross section numbering begins with R.S. 1S below Imperial Dam and progresses downstream to R.S. 20S near the Southern International Boundary. The 33 sections below Laguna Dam are surveyed by the International Boundary and Water Commission and the results are furnished to the Bureau of Reclamation.

The cross sections described above are surveyed annually and the average bed elevations and amount of bed material deposited or removed are computed using these data.

B. Suspended-Sediment Sampling

Suspended-sediment samples are taken at several stations along the river and diversion canals to determine both suspended-sediment

discharge and size-analysis of the suspended materials. Table 1 gives the location and pertinent data on active and inactive suspended-sediment stations on the lower Colorado River. Stations reported herein are:

Grand Canyon, Needles Bridge, R.S. 41 $\frac{1}{2}$, R.S. 43 $\frac{1}{2}$, Water Wheel, Below Palo Verde Dam, Taylor Ferry, Adobe Ruins, 4S Ranch, Yuma, Gila Gravity Main Canal, and All-American Canal at Station 60.

Sediment records at the Grand Canyon Station date from October 1925 and were for many years an important "bench mark" record of sediment inflow in the upper basin. Since the closure of Glen Canyon Dam in 1963, this station measured only sediment from the mainstream and tributaries in the 100 miles of river between the dam and the gaging station. The station was discontinued in 1972 because of its reduced practical importance and technical difficulties in determining the sediment load.

A new sediment sampling station (4S Ranch) was established 13 miles downstream from Adobe Ruins in December 1971. Both suspended and total loads are being computed to give a better indication of sediment movement and deposition in the Imperial Division.

C. Total Sediment Load Computations

At eight sampling stations--Needles Bridge, R.S. 41 $\frac{1}{2}$, R.S. 43 $\frac{1}{2}$, Water Wheel, Below Palo Verde Dam, Taylor Ferry,

$\frac{1}{2}$ Topock Gorge Division.

Adobe Ruins, and 4S Ranch--surveys are made about twice a month to collect data for computation of total sediment load using the Modified Einstein Method. Measurements include discharge, suspended-sediment discharge, and water surface slope. Bed-material samples are usually collected once a month. A sediment rating curve is drawn each year from total-load computations and, by applying it to daily flows throughout the year, a total annual sediment load is computed. These surveys and computations have been made regularly since 1964. Total load is also computed for individual samples taken below Yuma Main Canal Wasteway.

D. Water-Surface Profiles

A water-surface profile at the estimated dominant discharge is computed periodically to determine changes in flow characteristics. These profiles are computed by standard backwater methods using the surveyed river sections previously described as basic data. Pre-1968 water-surface profiles, however, were computed by a different method, using rating curves established at various gages.

E. Bed Material Samples

Through 1970, a bed material sample was taken each year at each surveyed section to determine changes in bed materials. Since 1970, bed samples have been taken in even-numbered years only. These samples are analyzed and grain-size gradation curves are plotted. When requested by the Bureau of Reclamation, the International Boundary and Water Commission takes bed samples downstream of Laguna Dam. The last were taken in 1969.

V. EROSION AND SEDIMENTATION

A. Areas of Scour and Fill

1. General. Before construction of Hoover Dam, the river carried great quantities of sediment, particularly during floods, from upstream drainage areas to the lower reaches. Some sediment was deposited in the river channel and some was carried to the mouth of the river. The net result was a gradual rise in riverbed elevation.

After Hoover Dam was completed, most of the sediment load was deposited in Lake Mead, and clear water was released from the dam. Parker and Imperial Dams created two more sediment depositories which discharged clear water into the river. This water began eroding the deposits which had been laid down in previous years, recharging the river's sediment load, then redepositing the sediment in the backwater zone of the next downstream reservoir. Davis Dam and Headgate Rock and Palo Verde Diversion Dams were built later and caused further changes in the river's regime.

Changes of water surface and bed elevations in selected cross sections are shown on Figures 3, 4, and 5. Estimates of material eroded and deposited in the various reaches of the river are shown on Tables 3, 4, and 5.

2. Davis Dam to Lake Havasu. From Davis Dam to Big Bend, the river has naturally armored bed and banks, but clear water from Davis

Dam has consistently caused a small amount of scour. Below Big Bend, the river enters an alluvial valley where, in years before the channel was stabilized, there was substantial scour. Below R.S. 33, the river apparently had picked up a normal sediment load, because scour had lessened and turned to deposition below Mile 12 at Needles.

During the years 1949 through 1960, channel stabilization and improvement work was performed between Big Bend and Topock. This work was successful in reducing scour of the bed and banks. As part of that work, a four-mile section of the river immediately above R.S. 40 at Topock Bridge was purposefully overexcavated as a settling basin, and a dredge was operated there almost continuously from late 1957 through late 1967. In 1967, the dredge was removed and filling occurred. Dredging in the settling basin resumed in February 1971 and continued until January 1974 when the dredge was again removed for other work.

Between R.S. 40 and R.S. 43.9 (in Topock Gorge), deposition was relatively constant until 1957 when the settling basin had been put in operation. Since then the canyon has been predominantly scoured, with the resulting sediment deposited in the lower gorge and the upper end of Lake Havasu. Between October 1967 and June 1968, channel dredging was performed in a 1-1/2-mile reach immediately below Topock.

3. Parker Dam to Imperial Dam. The pattern of scour and deposition between Parker and Imperial Dams was caused primarily by three factors: the clear water issuing from Parker Dam; the backwater

effects of Imperial Dam; and a concave river profile with steeper slopes in the upstream reaches than in the downstream reaches. A balance reach 10 miles long developed near River Section 22, and within 2 years after closure of the dams consistent scour occurred above this reach and deposition occurred below it.

The construction of Headgate Rock and Palo Verde Diversion Dams, channel training structures, and recent dredging and realinement of sections of the channel have changed and obscured the scour and fill patterns between Parker Dam and Adobe Ruins. It is now difficult to determine a definite pattern in this reach. Table 4 shows large amounts of material removed between Taylor Ferry and Adobe Ruins in 1965, 1966, and 1967, which was due to scour induced by downstream channel dredging and not natural erosion. Since 1968, the dredged channel below Taylor Ferry has partially refilled.

From Adobe Ruins to Imperial Dam, river deposition was consistent until 1964, when scour began. This is probably due to two causes: sediment accumulation in the channel reaching an equilibrium point so that most of the incoming sediment moves through the reach; and complete upstream channel improvements reducing the sediment load to a point where the river can pick up and carry additional sediment.

A tabulation of the annual sediment inflow, outflow, and trap efficiency for the Imperial Division is shown in Table 6. Trap efficiency, which provides a common basis for comparing annual aggradation,

is defined as the difference in sediment inflow and outflow divided by the sediment inflow, expressed as a percent.

4. Imperial Dam to the International Boundary. Because of low flows below Imperial Dam, the amount of scour and fill is much smaller than in the reaches above Imperial Dam. Deposition has been predominant throughout the reach, but scour has occurred in some years having higher flows. See Table 5.

B. Suspended-Sediment Transport

1. Main Stem. Suspended-sediment loads are showing a general reduction for the full length of the river. The suspended-sediment load at Grand Canyon, shown on Table 7, has been reduced by the 1963 closure of Glen Canyon Dam. At the suspended-sediment measuring stations between Davis Dam and Lake Havasu, concentrations have also shown a general decline (Table 8). The same trend has occurred between Parker Dam and Imperial Dam, though the values shown in Table 9 do not cover a long-enough period to illustrate this trend. Suspended-sediment concentrations at Yuma (see Table 10) have shown a steady decline and, with the recent low flows, the suspended-sediment load has been particularly small. The increase for 1973 is attributable to flood discharge from the Gila River. Suspended-sediment data at the Northerly International Boundary for recent years is presented in Table 11.

2. Canals. Figure 6 shows suspended-sediment concentrations in the inlet channels and at Station 60 downstream of the All-American

Canal desilting works; Figure 7 shows suspended-sediment concentrations in the Gila Gravity Main Canal at Station 144+50 below the settling basin. Both canals divert water from Imperial Dam: the former on the California side and the latter on the Arizona side.

C. Total Sediment Transport

Computations of total sediment load by the Modified Einstein Method were started on a regular basis in 1964. Individual computations for 1972 and 1973 are shown on Tables 12 through 20 for the following stations: Below Needles Bridge, R.S. 41 $\frac{1}{2}$, R.S. 43 $\frac{1}{2}$, Water Wheel, Below Palo Verde Dam, Taylor Ferry, Adobe Ruins, 4S Ranch, and Below Yuma Main Canal Wasteway. Annual summaries are shown on Tables 21 and 22.

No definite trend can be determined over the short period for which computations have been made. The low concentrations at R.S. 43 and Adobe Ruins since 1967 have probably occurred because some of the suspended sediment was trapped in recently dredged reaches above the sampling stations.

D. Changes in Water-Surface Profile

Water-surface profiles are shown on Figures 8 through 12. The water surface between Davis Dam and Lake Havasu appears to be continuing a slow downward trend, but the water surface in other reaches of the river has remained substantially the same for several years.

1/ Topock Gorge Division.

As previously explained, adoption of a new method of computing water-surface profiles initiated in 1968 may have introduced minor differences in the computed elevations.

E. Changes in Size of Suspended Material

Size analyses of suspended material in Imperial Reservoir, at Yuma, and at Needles Bridge are shown on Figures 13, 14, and 15. Analyses for 1934 and 1935-36, shown on Figures 13 and 14, represent pre-Parker Dam conditions.

F. Changes in Size of Bed Material

Size analyses of bed-materials samples are shown on Figures 16 through 26. The bed material is now generally coarser than before the dams were built, but no definite trend can be established which would cover all of the sections. At R.S. 28, just below Davis Dam, the channel has naturally armored itself and bed material is now too coarse for sampling with available samplers.

VI. DAMS AND RESERVOIRS

A. Dams and Reservoirs on the Lower Colorado River

The following tabulation lists pertinent data for dams and reservoirs located along the lower Colorado River.

| <u>Dam</u> | <u>Reservoir</u> | <u>Date of Closure</u> | <u>Storage Capacity in Acre-Feet</u> | <u>Remarks</u> |
|---------------|------------------|------------------------|--------------------------------------|--|
| Hoover | Lake Mead | 1935 | 29,755,000 ^{1/} | Active capacity of 17,353,000 acre-feet. Operated by USBR. |
| Davis | Lake Mohave | 1951 | 1,818,000 | Active capacity of 451,000 acre-feet. Operated by USBR. |
| Parker | Lake Havasu | 1938 | 648,000 ^{2/} | Active capacity of 180,000 acre-feet. Operated by USBR. |
| Headgate Rock | Lake Moovalya | 1942 | None | Irrigation diversion to Colorado River Indian Reservation. Operated by Bureau of Indian Affairs. |
| Palo Verde | --- | 1958 | None | Irrigation diversion to Palo Verde Irrigation District. |
| Senator Wash | --- | 1966 | 13,836 | Off stream reservoir upstream of Imperial Dam. Active capacity of 12,259 acre-feet. Operated by USBR. |

1/ Based on the Lake Mead Sedimentation Survey of 1963-64.

2/ Based on resurvey of the top 20 feet of reservoir in April 1957.

| <u>Dam</u> | <u>Reservoir</u> | <u>Date of Closure</u> | <u>Storage Capacity in Acre-Feet</u> | <u>Remarks</u> |
|------------|------------------|--------------------------------|--|---|
| Imperial | --- | 1938 | None | Irrigation diversion to All-American Canal and Gila Gravity Main Canal. Operated by USBR. |
| Laguna | --- | 1909 | None | Obsolete for irrigation diversion. Forms a downstream control for Imperial Dam. |
| Morelos | --- | 1950 | None | Irrigation diversion to lands in Mexico. Operated by Mexico. |

B. Operation of the Reservoirs

Hydrographs of levels in Lakes Mead, Mohave, and Havasu, and of discharges at Hoover Dam, Davis Dam, Parker Dam, and the Colorado River near Yuma are shown on Figures 28, 29, 30, and 31. Releases from the various dams are scheduled to meet downstream diversion requirements, including water delivery to Mexico. Water released through the dams is used to produce power; power requirements influence release pattern, but not the total volume released over a major period of time.

Each year estimates are made of the monthly requirements at each of the diversion points for the coming year. Estimates are then made of the necessary average monthly releases from Parker and Davis Dams to meet these requirements. The estimates of releases are based on downstream diversion requirements only: the amount of power that can be produced is determined from the releases.

Releases from Hoover Dam are scheduled to meet the total downstream water requirements for each year. Monthly diversions, however, are adjusted to meet a more efficient power production schedule, with reregulation provided by Davis Dam.

During the year, daily releases from Parker and Davis Dam are determined weekly based on actual water orders. The average daily releases are fluctuated during the day to meet an efficient power generating schedule. Monthly releases from Hoover Dam are adjusted as necessary during the year to accommodate the difference between estimated water requirements and actual orders.

Although Davis and Parker Dams impound nearly 2-1/2 million acre-feet of storage, not all of this is available for riverflow regulation. Parker Dam was primarily constructed as a forebay for the Metropolitan Water District's Colorado River Aqueduct which conveys water to the southern California coastal plain. Only the top 10 feet, containing 180,000 acre-feet of storage, are reserved for river regulation and flood control. Of the 1,818,000 acre-feet of storage capacity behind Davis Dam, the top 17 feet, containing 451,000 acre-feet of storage, are normally used for river regulation.

Senator Wash Reservoir is an off stream reservoir on the California side of the Colorado River just above Imperial Dam. Six reversible pump turbines are used to pump water from the river to the reservoir and to generate power when water is released. When Parker Dam releases water, it takes three days to reach Imperial Dam. Irrigation diversion

requirements often change between the time water is released from Parker Dam and the time it arrives at Imperial Dam. Excess water entering Imperial Reservoir is stored, then returned to the river as needed for use in the All-American and Gila Canal Systems, and the schedule to Mexico. Uncontrolled water previously lost to the United States, is now saved by operations at Senator Wash Reservoir.

C. Reservoir Sedimentation

1. Lake Mead. A survey of Lake Mead was made by the Geological Survey in 1948 and 1949, and the resulting report entitled "Lake Mead Comprehensive Survey of 1948-49" was published in February 1954. A second survey made in 1963 and 1964 by the Coast and Geodetic Survey was interpreted by the Bureau of Reclamation. The final report on that survey entitled "The 1963-64 Lake Mead Survey" was published in August 1970. Sedimentation data computed from these surveys are given below. The dates shown are those taken for computation purposes. The first date, February 1, 1935, is when the gates were closed at Hoover Dam.

| <u>Date of Survey</u> | <u>Period (years)</u> | <u>Total Sedimentation (acre-feet)</u> | <u>Mean Annual Sedimentation (acre-feet)</u> |
|-----------------------|-----------------------|--|--|
| 2-1-35 | 13.7 | 1,424,000 | 104,000 |
| 9-30-48 | 16.0 | 1,292,000 | 80,750 |
| 10-14-64 | — | — | — |
| Total | 29.7 | 2,716,000 | 91,450 ^{1/} |

^{1/} Mean Annual Sedimentation, 2-1-35 to 10-14-64.

Glen Canyon Dam, closed in 1963, has virtually eliminated the upper basin as a source of sediment inflow into Lake Mead.

2. Lake Mohave. Nearly all the inflow to Lake Mohave is clear water discharged from Lake Mead. The amount of sediment deposited in the reservoir is small.

3. Lake Havasu. The level of Lake Havasu is normally maintained between elevation 440 and 450. Since sediment deposited below elevation 440 does not affect operation of the reservoir, a resurvey of the reservoir in 1956 covered only the top 20 feet, elevation 430 to 450. In the 16 years between closure of Parker Dam and the resurvey, 58,100 acre-feet of sediment were deposited in the upper 20 feet, showing a loss of 15 percent of the original capacity of that part of the reservoir. No surveys of reservoir sedimentation have been made since that time. It is estimated, however, that only 12,000 acre-feet of sediment inflow to the reservoir occurred between 1957 and 1970. Upstream channelization and the maintenance of Topock Settling Basin have been major factors in reducing sediment inflow.

4. Diversion Dams. There are diversion pools behind Headgate Rock and Palo Verde Diversion Dams, but the amount of storage is not significant. No determination of sediment accumulation in these pools has been made.

Imperial Dam was designed and built as a diversion to raise the water surface so that irrigation diversions could be made. When first built, it created an impoundment of 85,000 acre-feet, which was

expected to fill with sediment. Silt deposits now extend downriver to Imperial Dam. In many upstream areas of the diversion pool, backwaters are isolated from the riverflow so that their trap efficiency is much reduced. It is estimated that the total drainable impoundment above Imperial Dam is about 10,000 acre-feet. In recent years, the Imperial diversion pool is customarily held about one foot below the sill elevation (181.0). This provides about 1,000 acre-feet of capacity which is used to supplement storage at Senator Wash Reservoir and provides additional storage for reregulation at this important diversion point.

Laguna Dam, no longer used as a diversion structure, has a diversion pool with an effective capacity of a few hundred acre-feet. This storage space is also used to supplement regulating storage at Senator Wash Reservoir and to store water used for sluicing at Imperial Dam. Water stored temporarily at Laguna Dam is later released as a part of the deliveries to Mexico at Morelos Dam.

Morelos Dam, which diverts water into the Alamo Canal for use in Mexico, does not impound a significant volume of water. No estimates of sedimentation behind the dam have been made.

VII. USE OF THE RIVER WATER

The principal uses of Colorado River water are for irrigation, domestic water supply, power production, and recreation.

A. Irrigation and Domestic Uses

Diversion of Colorado River water for irrigation was begun in the Mohave, Parker, Palo Verde, and Yuma Valleys before the turn of the century. The first diversions to Imperial Valley were made in 1901 through the Alamo Canal which flowed partly through Mexico. These early diversions suffered from floods, water shortages, and sedimentation. The Boulder Canyon Project was authorized to alleviate these problems, and the construction of Hoover Dam and subsequent dams and diversion works has made possible vast developments dependent on the river.

Cotton, summer and winter vegetables, citrus, and other crops are irrigated with water from the Colorado River. Fertile soil, ideal climate, and low-cost water has created some of the most productive agriculture in the United States.

The Metropolitan Water District of Southern California diverts water from Lake Havasu and carries it 200 miles for use in the Los Angeles-San Diego megalopolis. These diversions began in 1939. Other significant diversions from the river are identified in Table 23 and Figure 32.

B. Power Production

Generation of power at Hoover Dam was officially begun on October 26, 1936, with installation of the first generating unit. Since then, 16 more generating units have been added; the final one that completed the power installation at Hoover Dam went on line in December 1961. Total rated capacity of the powerplant is now 1,344,800 kilowatts. The Department of Water and Power of Los Angeles, California, and the Southern California Edison Company, as agents of the United States, operate the generating units.

Generation of power at Davis Dam was officially begun on January 5, 1951, and all five generating units were completed that year. Total rated capacity of the plant is 225,000 kilowatts. Power generating at Parker Dam began on December 13, 1942, and all four generating units were completed during 1942 and 1943. Total rated capacity of the plant is 120,000 kilowatts. The Bureau of Reclamation operates the powerplants at both dams.

Senator Wash Dam has six pump-turbines which came online in January 1966. Each unit has a rated generating capacity of 1,200 kilowatts making a total plant capacity of 7,200 kilowatts. It also is operated by the Bureau of Reclamation.

The net power generated at each plant for the past few years is shown on the following page.

| Calendar Year | Net Power Generation in Kilowatt-Hours | | | |
|---------------|--|-------------|-------------|-------------------------|
| | Hoover | Davis | Parker | Senator Wash |
| 1964 | 2,882,103,500 | 943,553,422 | 451,196,076 | |
| 1965 | 2,669,369,300 | 889,620,368 | 431,940,230 | |
| 1966 | 2,868,302,000 | 920,076,000 | 437,122,659 | |
| 1967 | 2,924,202,600 | 897,667,645 | 419,531,293 | 2,413,000 ^{1/} |
| 1968 | 2,913,906,000 | 931,649,000 | 443,095,922 | 930,000 |
| 1969 | 3,016,430,791 | 908,334,977 | 430,428,440 | 958,000 |
| 1970 | 3,184,014,813 | 927,148,600 | 438,985,991 | 1,294,000 |
| 1971 | 3,196,533,292 | 960,607,000 | 450,012,251 | 1,387,000 |
| 1972 | 3,250,997,536 | 957,231,000 | 455,513,369 | 1,025,000 |
| 1973 | 3,417,289,240 | 945,717,000 | 455,116,154 | 1,616,700 |

1/ Power produced, January 1966 through December 1967.

Since 1952, all water released has generated power, except for a small amount for testing.

C. Recreation

The river represents a tremendous recreational resource. In 1969, there were 9,000,000 visitor-days spent by recreationists in fishing, boating, camping, and other activities. Recreational uses of the river are considered in scheduling releases from the various dams. An effort is made to keep flows as high as possible (especially during weekends and special events) to facilitate boating and other recreation.

VIII. PHYSICAL CONTROL OF THE RIVER

The construction of Hoover, Davis, Parker, and Imperial Dams largely solved flood and drought problems which had long retarded development of the lower Colorado River. Flow control did not, however, eliminate all the problems. The regime of the river has been and will continue to be altered by the dams and reservoirs. Some regime changes were detrimental and corrective work had to be undertaken.

A. Emergency Work

The first major problem was at Needles, California. The river immediately upstream from Topock flows through an alluvial valley. In past years, considerable meandering occurred here accompanied by a general aggradation of the valley floor. From 1941 through 1944, aggradation of the riverbed and the valley floor accelerated. By the end of 1944 the result was that, instead of wandering, the river had spread out over the lower half of the valley forming a swamp through which the water flowed in several small channels. The upstream water surface rose so much that serious flooding occurred at Needles. In 1944, Congress authorized emergency protective measures at Needles and, in 1946, extended the authority contained in the Colorado River Front Work and Levee System Act to give the Bureau of Reclamation wider authority to deal with river problems.

Slight degradation took place after 1945, and by late 1948 a minor channel had opened on the California side of the valley with overflow still feeding the swamp. The threat to Needles, however, was only slightly diminished. Channelization and levee construction were initiated in 1949 to protect Needles and the work was finished in 1951. Monthly fluctuations of the gage height at Needles and Topock Bridge for a flow of 15,000 ft³/s are shown on Figure 27, which illustrates the changes that had taken place in the river near Needles.

The Palo Verde Irrigation District was also beset with problems caused by aggradation and degradation of the river. Degradation of the channel and a consequent lowering of the water surface at the District's diversion point began in 1940. The problem became so serious that in 1944 Congress authorized emergency funds for construction of a temporary weir to restore and stabilize the water-surface elevation. Work began soon after appropriation of funds, and a rock weir was completed in April 1945. In 1954, construction of a permanent diversion dam was authorized and the dam was completed in 1958.

At the outfall of the Palo Verde Drain, rising water levels began to interfere with the drain discharge. A cutoff across a bend of the river near the outfall was made in 1947 to lower water levels and provide a temporary solution to the problem.

B. Formulation of Comprehensive Plan

As one emergency situation after another was dealt with, it became clear that comprehensive plans for river stabilization and control were

needed. The first such plan, entitled "Report on Comprehensive Plan, Colorado River Channelization, Big Bend to Needles Division," was published in April 1955. Reports on other divisions followed, and by 1969 comprehensive river management plans had been approved for the Topock Gorge, Parker, Palo Verde, Cibola, and Yuma Divisions, in addition to the Mohave Valley Division. The primary purposes of the plans are:

1. To provide a stable and confined channel for the river which will carry normal flows efficiently and safely convey floods.
2. To conserve water by narrowing wide reaches of the river, confining the river to a single channel where several channels now exist, limiting backwater areas, controlling phreatophyte growth, and by other measures as required.
3. To preserve and enhance the river as an attractive recreational area and habitat for fish and wildlife.

C. Status of River Control Work

1. Davis Dam to Parker Dam. After completion of the emergency channel work between Needles and Topock, sediment which had formerly been deposited in that reach was sluiced through the new channel and deposited in Topock Gorge. To control the source of sediment, channel dredging and related work were undertaken between Big Bend and Needles in 1952 and completed in 1960.

In 1955-56, a settling basin was dredged upstream of Topock and, until October 1967, a dredge was kept continually at work in the basin to reduce sediment entering Topock Gorge. After removal of the dredge, the basin gradually filled and dredging was resumed in February 1971. In January 1974, the dredge was removed for other work.

A dredging plan was approved for the Topock Gorge Division that would increase the hydraulic efficiency of the channel to offset Lake Havasu backwater effects and sediment deposits which have accumulated in the Gorge since construction of Parker Dam. The plan would protect completed upstream work against rising water levels in Topock Gorge, provide additional water salvage and sediment control, and provide fish and wildlife and recreational features. The approved plan limited initial dredging to the 1.7 miles below Topock and the 4 miles just upstream of Lake Havasu. In October 1967, the dredge was withdrawn from the settling basin and began work in the upper section. This reach was never completed, however, as a directive by the Secretary of the Interior suspended the work in June 1968 because of opposition by certain conservation interests. At that time, the Bureau of Reclamation and the Fish and Wildlife Service were instructed to further evaluate the physical and ecological changes taking place in the Gorge.

2. Parker Dam to Imperial Dam. Between Parker Dam and Headgate Rock Dam, a recreational development is under consideration by the Bureau of Reclamation. This development centers around a power boat race course located upstream from Headgate Rock Dam.

Between Headgate Rock Dam and Alligator Bend, increasing recreational use and land development made bank stabilization urgent.

Channel improvement and bank stabilization by land-based equipment was begun in 1966 and substantially completed in 1967. The work consisted primarily of confining overwide sections of the river between training structures and stabilized banklines.

Between Alligator Bend and Palo Verde Diversion Dam, channel stabilization and river control have not yet begun. An approved plan calls for dredging the riverbed to produce a deeper channel with a more uniform gradient than in the next upstream reach. Channel alignment will be improved and banklines stabilized. Some backwater areas will be filled with dredged material, and other backwaters in abandoned reaches of the channel will be dredged to create permanent fish and wildlife habitat and recreational areas. The "Report of Task Force, Review of the River Management Program," published in July 1971 recommended that alternative plans for this section of the Parker Division be considered to reduce the environmental impact. Several plans are being evaluated.

Channel improvement work was initiated in 1962 from Palo Verde Diversion Dam to Taylor Ferry (Palo Verde Division), and completed in 1967. It consisted of stabilized banklines and training structures to prevent further meandering of the river and was constructed with land-based equipment. Selected backwater areas have been developed to enhance the area for fish and wildlife and several structures were installed to provide circulating water to maintain the habitat.

The natural channel from Taylor Ferry to Adobe Ruins (Cibola Division) was shallow and meandering. A program to improve it by dredging and levee construction was initiated in 1964 and completed in 1970. Part of the improved channel is the natural riverbed and part is a new cut (opened March 10, 1970) which isolates some of the existing channel. Construction of recreation facilities and fish and wildlife habitat is also an important part of the program.

The present alignment of the river between Adobe Ruins and Imperial Dam was formed by aggradation throughout the reach partly caused by the construction of Imperial Dam. Most incoming sediment is still deposited within the reach in areas outside the main channel. Completed and future work in upstream reaches, however, should substantially reduce the sediment inflow. This reach is somewhat similar to the Needles area, in that aggradation was caused by backwater effects of a downstream dam. But unlike the situation at Needles in which deposition took place so rapidly that the channel was nearly obliterated, the deposition in this reach has been orderly. Throughout the reach, much sediment has been deposited on side bars and natural levees which have helped to maintain the integrity of the channel. Channel and backwater improvement through the reach may eventually be necessary, but formulation of a plan of work has not yet been undertaken.

3. Imperial Dam to Laguna Dam. The 5-mile reach between Imperial Dam and Laguna Dam was originally part of the Laguna diversion pool. This pool filled quickly with sediment and the river formed a well-defined channel between the two dams. The reach receives a large

amount of sediment, mostly from the All-American Canal desilting works. Because of the need to conserve water, the scheduling of large sluicing flows to carry sediment downriver had not been practical in recent years and the river channel began to deteriorate. A settling basin with connecting channels between Imperial and Laguna Dams was completed in 1965. Sediment is now trapped in the basin where a dredge periodically pumps it out for disposal on land.

4. Laguna Dam to the International Boundary. The river channel from Laguna Dam to the diversion pool above Morelos Dam was formed by flows of moderate volume during times when water was in excess of needs in the United States. With increasing requirements and better control of the river, the flows in this reach have been steadily decreasing. They are expected to range between 250 and 1,500 ft³/s. The channel has deteriorated because of recent low flows. Shallow depths, overwide sections, and thick phreatophyte growths prevail. An approved plan calls for dredging the channel to a lower grade, a narrower section, and a flatter gradient to provide an efficient section for both normal and flood flows. Improvement of fish and wildlife habitat and recreational areas is a part of the project. In January 1969, dredging was begun below Laguna Dam and proceeded downstream 5.8 miles until December 1969 when the dredge was moved to Mittry Lake, an off stream lake being improved for fish and wildlife habitat. The "Report of Task Force, Review of the River Management Program" recommended that alternative plans be considered which have less environmental impact. The plan of development for the Yuma Division is being reevaluated.

The river in the reach between Morelos Dam and the Southern International Boundary is no longer important as a channel for carrying irrigation water, and inadequacies have developed in its capacity to convey floodflows. These will require future correction, but planning has not yet been undertaken. Because the river in this reach is the International Boundary, all work must be coordinated with the International Boundary and Water Commission.

TABLES

TABLE 1
SUSPENDED SEDIMENT STATIONS IN THE
LOWER COLORADO RIVER

| Name of Station or Group | Approximate Location of Station | Dates of Records | Sampler Used | Frequency of Sampling | Agency Obtaining Samples | Agency Analyzing Samples | Method of Size Analysis |
|----------------------------------|---|--|---|------------------------|---------------------------|--------------------------------|-------------------------|
| Lees Ferry | Just upstream from Colorado River Mile 0.0 | Nov. 10, 1942 to Sept. 29, 1944; continuous since Oct. 1, 1947. | "Colorado River" type U. S. D-43 | Daily | Geological Survey | Geological Survey | |
| Paria River | Just upstream from Junction of Colorado River | Continuous since Oct. 1, 1947. | U. S. D-43 | Daily | Geological Survey | Geological Survey | |
| Little Colorado River | Near Cameron, Arizona | Continuous since Oct. 1, 1947 to September 1970. | U. S. D-43 | Daily | Geological Survey | Geological Survey | |
| Grand Canyon | Colorado River Mile 87.4 | Jan. 1935 through Sept. 1942; Sept. 1943 to Sept. 1972. | "Colorado River" type to about April 1944 U. S. D-43 thereafter | Daily | Geological Survey | Geological Survey | |
| Parah Creek | Near Fredonia, Arizona | Continuous since Oct. 1973. | U. S. D-43 | Daily | Geological Survey | Geological Survey | |
| Virgin River | Littlefield, Arizona | Oct. 1947 to Sept. 1968. | U. S. D-43 | Daily | Geological Survey | Geological Survey | |
| Needles Bridge | Needles, California | Continuous since July 1955. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| River Section 41 | Colorado River Mile 470.6 | Continuous since Sept. 1955. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Near River Section 43 | Colorado River Mile 475.8 | Continuous since Sept. 1955. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Water Wheel | Colorado River Mile 550.6 | Continuous since April 1, 1958. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Blythe At Palms | Blythe, California | Continuous since Sept. 1955. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Taylor Ferry | Colorado River Mile 597.5 | Continuous since May 9, 1939. | U. S. D-49 2/ | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Adobe Ruins | Near Cibola | Continuous since Nov. 1956. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| 43 Ranch | Colorado River Mile 632.6 | Continuous since December 1971. | U. S. D-49 | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Imperial Dam Inlet Channels | Colorado River Mile 658 | Jan. 1958 to April 1973. | U. S. D-43 | 1-4 per Mo. | Imp. Irrig. District | Imp. Irrig. District | |
| Imperial Dam Sludge Pipes | Colorado River Mile 658 | Continuous since Nov. 7, 1945. | Special | 1-4 per Mo. | Imp. Irrig. District | Imp. Irrig. District | |
| Imperial Dam Sluiceway | Colorado River Mile 658 | Continuous since June 14, 1938. | U. S. D-43 | 6 to 48 per Yr. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| All-American Canal Sta. 60 | Crossings | Jan. 27, 1939 to Mar. 1, 1939; Continuous since Oct. 26, 1940 | | | | | |
| All-American Canal Sta. 105 | P.K. Forebay | Continuous since July 9, 1947. | U. S. D-43 2/ | 1-4 per Mo. | Imp. Irrig. District | Imp. Irrig. District | None |
| All-American Canal Sta. 1973 | East Highline | Continuous since June 20, 1945. | | | | | |
| All-American Canal Sta. 2973 | | Continuous since Mar. 29, 1948 1/ | | | | | |
| All-American Canal Sta. 3258 | At Alamo River | Mar. 22, 1941 to June 17, 1947; Continuous since April 13, 1948 1/ | | | | | |
| Yuma Main Canal | Siphon Drop Laboratory | Continuous since Feb. 25, 1946 1/ | U. S. D-43 2/ | 1 or 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | None |
| Gila Gravity Canal | Sta. 114+50 | Continuous since Aug. 1941 Jan. 1943 to April 1971. | U. S. D-43 2/ | 2 per Mo. | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| East Highline Canal | At All-American Canal | Continuous since Sept. 1952. | U. S. D-43 | per Mo. | Reclamation | Reclamation | |
| Central Main Canal | At All-American Canal | Continuous since Feb. 28, 1946. | | 1 or 2 per Mo. | Imp. Irrig. District | Imp. Irrig. District | None |
| West Side Main Canal | At All-American Canal | Continuous since Feb. 7, 1946. | | 1 or 2 per Mo. | Imp. Irrig. District | Imp. Irrig. District | None |
| Yuma/Below Yuma Main Canal W.W. | Colorado River Mile 676.7 | May 1909 to Oct. 1909 April 1910 through Dec. 1942 | "Yuma" type | 1 per Mo. to 3 per Wk. | Geol. Survey & Recla. | Bureau of Reclamation | None |
| | | April 1933 to June 1934. Continuous since June 1938. | U. S. D-43 2/ | | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| | | Continuous since 1956. | U. S. D-48 and D-49 | 1 per Wk. | Int. Bound. & Water Comm. | Bureau of Reclamation & Mexico | Sieve |
| Northerly International Boundary | Colorado River Mile 683 | Continuous since 1956 | U. S. D-48 and D-49 | 1 per Wk. | Int. Bound. & Water Comm. | Bureau of Reclamation & Mexico | Sieve |
| Southerly International Boundary | Colorado River Mile 703 | Continuous since 1946. | U. S. D-48 & D-49 | 1 per Mo. | Int. Bound. & Water Comm. | Bureau of Reclamation & Mexico | Sieve |

^{1/} Samples obtained by Imperial Irrigation District.
^{2/} Tait-Binckley used prior to Oct. 1, 1947.

Table 1 (Continued)

SUSPENDED SEDIMENT STATIONS - LOWER COLORADO RIVER

(INACTIVE STATIONS)

| Name of Station or Group | Approximate Location of Station | Dates of Records | Sampler Used | No. of Samples | Government Obtaining Samples | Agency Analyzing Samples | Method of Size Analyses |
|--------------------------|---------------------------------|---|--|-----------------|------------------------------|--------------------------|--|
| Escalante River | Escalante, Utah | May 3 to Aug. 24, 1940 | Qt. Jar, Fig. 8 hole in lid | 8 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| Kanab Creek | Near Glendale, Utah | March 21 to April 18, 1940 and April 30, 1941 | Qt. Jar, Fig. 8 hole in lid | 5 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| Johnson Creek | Skutumpah, Utah | March 4, 1940 to Sept. 17, 1940 | Qt. Jar, Fig. 8 hole in lid | 12 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| Virgin River | Virgin, Utah | Jan. 13, 1936 to Nov. 1, 1936 Jan. 13, 1939 to June 3, 1944 One sample, March 2, 1941 | Jar, Fig. 8 hole in lid | 181 543 1 | | | |
| Virgin, N. Fork | Near Springdale, Utah | Oct. 10, 1936, May 6 and July 25, 1941 | | 3 | | | |
| La Verkin Creek | Near La Verkin, Utah | Jan. 29, 1941 to May 19, 1942 | | 71 | | | |
| Ash Creek | Near New Harmony | April 7, 1939 to Jan. 25, 1943 | | 58 | | | |
| Big Creek | At Reservoir Site | Sept. 29, 1939 to Sept. 17, 1940 May 15, 1941 to Aug. 6, 1941 | | 22 | | | |
| Kanara Creek | Near Kanara | April 15 and Sept. 4, 1940; April 30 to Aug. 6, 1941; April 15 to 28, 1942 | Quart Fruit Jar, Fig. 8 hole in lid | 19 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer Analyses of Certain Combined Groups |
| | Near N. Harmony | April 1 and Sept. 4, 1940; March 3, May 7 and 14, 1941; April 15 and July 22, 1942 | | 7 | | | |
| Santa Clara R. | Gunlock, Utah | April 17, 1939 to July 25, 1941 (intermittent) | | 21 | | | |
| | Near Santa Clara, Utah | May 8, 1939 to April 7, 1944 | | 60 | | | |
| Moody Wash | Near Veyo, Utah | April 17, 1939 to Feb. 28, 1941 (intermittent) | | 10 | | | |
| Ivins Dry Wash | Near Santa Clara, Utah | Jan. 24, 1941 to July 26, 1941 | | 9 | | | |
| Kanab Creek | Near Glendale, Utah | March 29, 1944 to May 6, 1944 | | 50 | | | |
| River Section 33 | Colorado River Mile 447.3 | July 5, 1944 - Sept. 17, 1958 | US D-49 | 23 | Bureau of Reclamation | Bureau of Reclamation | Sieve |
| Red Cloud Cable | Colorado River Mile 635.4 | Feb. 8, 1936 to Aug. 29, 1939 | 1,000 c.c. Tait-Binckley | 96 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| Imperial Dam Site | Colorado River Mile 657.8 | May 15, 1933 to Jan. 22, 1934 May 15, 1935 to July 26, 1935 Aug. 2, 1932 to Jan. 24, 1936 | 500 c.c. Tait-Binckley 500 c.c. " 1,000 c.c. " | 69 10 18 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| All-American Canal | Sta. 598 | Unnamed Wash | Nov. 2, 1940 to Jan. 14, 1941 | 4 | | | None |
| | Sta. 810 | | Jan. 28, 1941 to Apr. 22, 1942 | 36 | | | |
| | Sta. 1173 | | Feb. 12, 1941 to July 16, 1946 | 101 | Bureau | Bureau | " |
| | Sta. 1900 | At Pilot Knob Above Drop No. 1 | July 22 to Dec. 30, 1947 1/2 | 10 | | | " |
| | | | June 17, 1942 to June 17, 1947 | 83 | of | of | " |
| | | | July 23 and Aug. 14, 1947 1/2 | 2 | | | " |
| | | | Sept. 10 to Dec. 30, 1947 1/2 | | Reclamation | Reclamation | " |
| | Sta. 1950 | | Mar. 6, 1941 to Apr. 7, 1942 | 32 | | | " |
| | Sta. 2180 | | May 6 and 25, 1942 | 2 | | | " |
| | Tailwater Crest Sluiceway | Colorado River Mile 662.5 | April 1933 to Oct. 1933 April 1933 to July 1934 June 1933 to July 1934 | 54 110 78 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| Jaguna Dam | Tuma Main Canal | R. C. Check R. C. Check | April 1933 to July 1934 June 1938 to July 1941 | 120 88 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| Alamo Canal | Hanlon Headin; | Approx. 1 mile below intake | Sept. 28, 1935 to Feb. 11, 1942 | 167 | Bureau of Reclamation | Bureau of Reclamation | Sieve and Hydrometer |
| | Alamo Mocho | Approx. 36 miles below intake | Nov. 30, 1935 to March 22, 1941 | 139 | | | None |
| Dogwood Canal | | At Highway 80 | May 10 and 24, 1948 | 2 | Imp. Irrig. District | | None |
| Central Main Canal | At Dogwood Road | | | 2 | Imp. Irrig. District | | None |
| Coachella Canal | Station 10 | | April 1945 to Sept. 1952 | 61 | Bureau of Reclamation | Bureau of Reclamation | None |

1/ Samples obtained by Imperial Irrigation District

Table 2

**GAGES IN OPERATION
COLORADO RIVER BELOW DAVIS DAM**

| NAME OF GAGE | OPERATED BY 3/ | RIVER MILE | MILES INTERVENING | REMARKS |
|-----------------------------------|----------------|------------|-------------------|------------------|
| <u>DAVIS DAM TO LAKE HAVASU</u> | | | | |
| Below Davis Dam | USGS | 423 | | Rated Recorder |
| Station 12 | USBR | 426 | 3 | Recorder Only |
| Big Bend | USBR | 432 | 6 | Recorder Only |
| Station 1090 | USBR | 443 | 11 | Recorder Only |
| Needles | USGS | 453 | 10 | Recorder Only 1/ |
| Topock | USBR | 464 | 11 | Recorder Only |
| R.S. 41 | USGS | 467 | 3 | Rated Recorder |
| R.S. 43 | USBR | 472 | 5 | Staff |
| <u>PARKER DAM TO IMPERIAL DAM</u> | | | | |
| Parker Dam | USGS | 511 | 16 | Rated Recorder |
| Parker | USBR | 527 | 25 | Recorder Only |
| Water Wheel | USBR | 550 | 20 | Recorder Only 1/ |
| Below Palo Verde Dam | USGS | 570 | 12 | Rated Recorder |
| PVID Gage Near Ehrenburg Bridge | PVID | 582 | 14 | Recorder Only |
| Taylor Ferry | USBR | 596 | 8 | Recorder Only 1/ |
| Cibola Operating Bridge | USBR | 604 | 8 | Recorder Only |
| Lower Cibola Bridge | USBR | 612 | 4 | Recorder Only |
| PVID Gage in Cibola Valley | PVID | 616 | 4 | Recorder Only |
| Adobe Ruins 2/ | USGS | 620 | 42 | Rated Recorder |
| Imperial Dam | USBR | 662 | | Stage Recorder |
| <u>IMPERIAL DAM TO MEXICO</u> | | | | |
| Below Yuma Main Canal Wasteway | USGS | 677 | 6 | Rated Recorder |
| Northerly International Boundary | USGS | 683 | 20 | Rated Recorder |
| Southerly International Boundary | USGS | 703 | | Rated Recorder |

1/ Rating Curve can be drawn from sediment sampling notes.

2/ Colorado River Below Cibola Valley (USGS nomenclature).

3/ USBR is U. S. Bureau of Reclamation; USGS is U. S. Geological Survey; PVID is Palo Verde Irrigation District.

Table 3

ESTIMATED VOLUMES OF RIVERBED MATERIAL
REMOVED AND DEPOSITED BETWEEN DAVIS AND PARKER DAMS

| Between Sections | Davis Dam to RS 29 | RS 29 to RS 30 | RS 30 to RS 33c | RS 33 to Mile 12 | Mile 12 to RS 40 | RS 40 to RS 43.9 |
|----------------------------|---------------------------------------|---|--------------------|---------------------|---------------------|---------------------|
| Period Approx. Dates | Mean Q Below Davis Dam (cfs) | VOLUME REMOVED OR DEPOSITED 1/ (-) Indicates Removal (+) Indicates Deposit (Thousands of Cubic Yards) | | | | |
| Sept. 1951 | | | | | | |
| Aug. 1952 | 18,700 | -1,217 | -1,317 | -5,843 | -1,624 | -62 |
| Aug. 1952 | | | | | | +963 |
| July 1953 | 18,900 | -601 | -274 | -934 | -314 | -668 |
| July 1953 | | | | | | +151 |
| June 1954 | 14,300 | -287 | -290 | -4,277 | +648 | +2,472 |
| June 1954 | | | | | | +1,842 |
| July 1955 | 13,800 | -266 | -1,104 | -3,611 | -726 | +600 |
| July 1955 | | | | | | +1,171 |
| July 1956 | 11,000 | -266 | -556 | -1,948 | +141 | +535 |
| July 1956 | | | | | | +368 |
| July 1957 | 10,500 | -468 | -294 | -3,758 | -43 | +744 |
| July 1957 | | | | | | +961 |
| July 1958 | 16,500 | +125 | -5 | -2,930 | -382 | -210 |
| July 1958 | | | | | | -369 |
| July 1959 | 11,500 | -373 | -2,855 | -358 | +599 | +374 |
| July 1959 | | | | | | +1,254 |
| July 1960 | 12,100 | -259 | -159 | -1,570 | -20 | -620 |
| July 1960 | | | | | | -761 |
| July 1961 | 12,100 | -755 | -1,753 | -8 | -181 | -505 |
| July 1961 | | | | | | +348 |
| July 1963 | 11,500 | +66 | -2,081 | -1,095 | -289 | -1,060 |
| July 1963 | | | | | | -725 |
| July 1964 | 11,400 | +697 | -251 | -373 | -57 | -1,077 |
| July 1964 | | | | | | +748 |
| July 1965 | 10,800 | -648 | +560 | -208 | -64 | +220 |
| July 1965 | | | | | | -346 |
| May 1966 | 10,600 | -220 | -74 | +329 | +6 | -589 |
| May 1966 | | | | | | -936 |
| Sept. 1967 | 12,100 | -422 | -589 | -1,803 | -432 | -1,517 |
| Sept. 1967 | | | | | | -570 |
| May 1968 | 9,370 | +127 | +124 | +353 | -51 | +835 |
| May 1968 | | | | | | -394 |
| May 1969 | 11,250 | +98 | -290 | +570 | +214 | +640 |
| May 1969 | | | | | | +764 |
| June 1970 | 11,400 | +277 | -651 | -807 | -254 | -324 |
| June 1970 | | | | | | -1,001 |
| July 1971 | 11,700 | +243 | -0- | -827 | +271 | -478 |
| July 1971 | | | | | | -114 |
| July 1972 | 11,100 | +40 | -105 | -40 | -141 | -804 |
| July 1972 | | | | | | +1,003 |
| July 1973 | 11,200 | -63 | +100 | +9 | +80 | -1,355 |
| Total Sept. 1951 | | | | | | -800 |
| Prnu July 1973 | | -4,172 | -11,864 | -29,129 | -2,619 | -2,849 |
| | | | | | | +3,557 |

For years prior to 1951 see Table I, Volume I, of "Report of River Control Works and Investigations, Lower Colorado River Basin", 1950-1951.

1/ Data in this table computed from cross-sectional measurements.

River sections RS 30 through RS 33C near Needles reflect removal by channel dredging during the years 1952 through 1960.

The reach from Mile 12 to RS 40 reflects removal by maintenance dredging in the settling basin from 1957 through 1967, and 1971 thru 1973.

The reach between R.S. 40 and R.S. 43.9 reflects removal by channel dredging between October 1967 and June 1968.

Table 4
ESTIMATED VOLUMES OF RIVERBED MATERIAL
REMOVED AND DEPOSITED BETWEEN PARKER AND IMPERIAL DAMS

| Between Sections | Parker Dam to P.V.I.D. Dam | P.V.I.D. Dam to Taylor Ferry | Taylor Ferry to Adobe Ruins | Adobe Ruins to Imperial Dam |
|----------------------------|--|---|-----------------------------------|-----------------------------------|
| Period Approx. Dates | Mean Q Below Parker Dam (cfs) | VOLUME REMOVED OR DEPOSITED 1/ (-) Indicates Removal (+) Indicates Deposit (Thousands of Cubic Yards) | | |
| Sept. 1937 | | | | |
| July 1951 | 17,738 | -94,732 | -75,012 | +17,131 |
| July 1951 | | | | +123,834 |
| Sept. 1952 | 17,738 | -3,618 | +924 | -2,615 |
| Sept. 1952 | | | | -4,331 |
| Aug. 1953 | 18,068 | -4,094 | -3,762 | -691 |
| Aug. 1953 | | | | -67 |
| July 1954 | 13,059 | +4,271 | +9 | +1,530 |
| July 1954 | | | | +2,781 |
| Oct. 1955 | 12,835 | +2,493 | +701 | -1,006 |
| Oct. 1955 | | | | +417 |
| Aug. 1956 | 12,776 | -1,553 | -370 | +147 |
| Aug. 1956 | | | | +567 |
| Mar. 1957 | 7,394 | +1,229 | +375 | -933 |
| Mar. 1957 | | | | +1,449 |
| Aug. 1958 | 15,362 | -4,555 | +879 | +930 |
| Aug. 1958 | | | | +1,169 |
| Aug. 1959 | 12,200 | +1,243 | -1,984 | +367 |
| Aug. 1959 | | | | +2,355 |
| Aug. 1960 | 11,042 | +1,136 | +1,199 | -2,165 |
| Aug. 1960 | | | | 0 |
| Mar. 1962 | 8,820 | -327 | +2,240 | -3,040 |
| Mar. 1962 | | | | +1,728 |
| Oct. 1963 | 10,770 | -1,340 | -828 | -572 |
| Oct. 1963 | | | | +1,658 |
| Sept. 1964 | 9,550 | -720 | +185 | +1,018 |
| Sept. 1964 | | | | +347 |
| Nov. 1965 | 8,340 | +1,349 | -11 | -1,666 |
| Nov. 1965 | | | | -312 |
| July 1966 | 9,340 | +954 | +180 | -483 |
| July 1966 | | | | -495 |
| Sept. 1967 | 9,270 | +3,388 | +64 | -2,546 |
| Sept. 1967 | | | | -386 |
| Aug. 1968 | 8,083 | +1,517 | -85 | +1,218 |
| Aug. 1968 | | | | +1,142 |
| Aug. 1969 | 9,277 | -1,161 | -1,079 | +902 |
| Aug. 1969 | | | | -1,604 |
| Sept. 1970 | 9,150 | -179 | +2,102 | -46 |
| Sept. 1970 | | | | +722 |
| Nov. 1971 | 9,300 | +901 | -2,471 | +1,297 |
| Nov. 1971 | | | | -1,468 |
| Sept. 1972 | 9,000 | +323 | -1,733 | +225 |
| Sept. 1972 | | | | -133 |
| Aug. 1973 | 9,100 | +223 | +2,227 | +947 |
| Total Sept. 1937 | | -93,252 | -76,250 | +9,949 |
| Thru Aug. 1973 | | | | +129,728 |

1/ Computed from change in river cross sections. Taylor Ferry to Adobe Ruins reach reflects removal by channel dredging during the years 1964 through 1967.

Table 5

ESTIMATED VOLUMES OF RIVERBED MATERIAL

REMOVED AND DEPOSITED BELOW IMPERIAL DAM 1/

| Between Sections | Imperial Dam to Laguna Dam | Laguna Dam to 6 S | 6 S | Total Imperial Dam to 8 S | 8 S | Morelos Dam to Morelos Dam | Morelos Dam to 20 S | Total Imperial Dam to 20 S |
|------------------|----------------------------------|---|--------|---------------------------------|---------|----------------------------------|---------------------------|----------------------------------|
| <u>Period</u> | | | | | | | | |
| Approx. Dates | Mean Q at Yuma (cfs) | | | | | | | |
| | | VOLUME REMOVED OR DEPOSITED | | | | | | |
| | | (-) Indicates Removal (+) Indicates Deposit | | | | | | |
| | | (Thousands of Cubic Yards) | | | | | | |
| Jan. 1940 2/ | | | | | | | | |
| Nov. 1955 | 8,300 | -3,480 | -2,490 | -5,647 | -11,617 | -1,808 | -74,118 | -87,543 |
| Nov. 1955 | | | | | | | | |
| Nov. 1956 | 1,200 | +48 | -91 | +43 | 0 | -17 | +1,187 | +1,170 |
| Nov. 1956 | | | | | | | | |
| May 1957 | 790 | +179 | +145 | +329 | +653 | +169 | +527 | +1,349 |
| May 1957 | | | | | | | | |
| Nov. 1957 | 1,590 | +125 | -169 | -629 | -673 | +143 | -334 | -864 |
| Nov. 1957 | | | | | | | | |
| May 1958 | 6,600 | +212 | +1,122 | +116 | +1,450 | +653 | +1,013 | +3,116 |
| May 1958 | | | | | | | | |
| Nov. 1958 | 2,030 | -33 | +338 | -90 | +215 | -490 | +417 | +142 |
| Nov. 1958 | | | | | | | | |
| May 1959 | 1,710 | -34 | +54 | -204 | -184 | -215 | +642 | +243 |
| May 1959 | | | | | | | | |
| Nov. 1959 | 1,130 | +11 | +38 | +23 | +72 | -64 | +135 | +143 |
| Nov. 1959 | | | | | | | | |
| May 1960 | 950 | +143 | -132 | -62 | -51 | -364 | +159 | -256 |
| May 1960 | | | | | | | | |
| Nov. 1960 | 960 | -123 | +26 | -103 | -200 | -47 | +45 | -202 |
| Nov. 1960 | | | | | | | | |
| May 1961 | 990 | +266 | +95 | +114 | +475 | +17 | +55 | +547 |
| May 1961 | | | | | | | | |
| Nov. 1961 | 980 | +9 | -100 | -93 | -184 | +19 | -514 | -679 |
| Nov. 1961 | | | | | | | | |
| May 1962 | 920 | +80 | +186 | +49 | +315 | +155 | +389 | +859 |
| May 1962 | | | | | | | | |
| Nov. 1962 | 1,120 | -200 | -41 | +23 | -218 | +53 | +400 | +235 |
| Nov. 1962 | | | | | | | | |
| May 1963 | 1,460 | -129 | +111 | -36 | -54 | -161 | -379 | -594 |
| May 1963 | Not Measured | | | | | | | |
| Nov. 1963 | 1,170 Nov. 1963 | +80 | +17 | +97 | +39 | +87 | +223 | |
| Nov. 1963 | | | | | | | | |
| June 1964 | 1,170 | +105 | +95 | +119 | +319 | +97 | -36 | +380 |
| June 1964 | | | | | | | | |
| Dec. 1964 | 880 Not Measured | +91 | -61 | +30 | -30 | -44 | -44 | |
| Dec. 1964 | | | | | | | | |
| May 1965 | 1,000 Not Measured | -43 | +67 | +24 | +66 | +769 | +859 | |
| May 1965 | | | | | | | | |
| Oct. 1965 | 990 Not Measured | +48 | -93 | -45 | -27 | -68 | -140 | |
| Oct. 1965 | | | | | | | | |
| Nov. 1966 | 850 Not Measured | +40 | +33 | +73 | -94 | +94 | +73 | |
| Nov. 1966 | | | | | | | | |
| Dec. 1967 | Not Measured | +6 | +23 | +29 | +197 | +158 | +384 | |
| Dec. 1967 | | | | | | | | |
| Dec. 1968 | Not measured | -202 | -87 | -289 | -54 | +430 | +87 | |
| Dec. 1968 | | | | | | | | |
| Nov. 1969 | Not Measured | +527 | -103 | +424 | -199 | -326 | -101 | |
| Nov. 1969 | | | | | | | | |
| Dec. 1970 | Not Measured | -282 | +21 | -261 | +38 | -120 | -343 | |
| Dec. 1970 | | | | | | | | |
| Dec. 1971 | Not Measured | -63 | -59 | -122 | +36 | -166 | -252 | |
| Dec. 1971 | | | | | | | | |
| Dec. 1972 | Not Measured | +70 | +92 | +162 | +54 | +225 | +441 | |
| Dec. 1972 | | | | | | | | |
| Total | | | | | | | | |
| Jan. 1940 | | | | | | | | |
| Dec. 1972 | -2,821 ^{3/} | -541 | -6,198 | -9,560 | -1,834 | -69,373 | -80,767 | |

1/ Data in this table computed from cross-sectional measurements taken by International Boundary and Water Commission.

2/ Data for Jan. 1940 to Nov. 1955 is for the following reaches: Imperial Dam to R.S. 2S; R.S. 2S to R.S. 6S; R.S. 6S to R.S. 8S; R.S. 8S to R.S. 10S; and R.S. 10S to R.S. 20S.

3/ Total through June 1964.

4/ Dredging was performed between Laguna Dam and R.S. 6S in 1969. Spoil was deposited within the channel and, therefore dredging is not reflected in computations of scour and fill.

TABLE 6
AGGRADATION AND TRAP EFFICIENCY
IMPERIAL DIVISION

| Year | Sediment Inflow | Sediment Outflow | Trap Efficiency |
|------|---------------------|---------------------|--------------------|
| | 1/ Thousand Tons | 2/ Thousand Tons | |
| 1964 | 1,944 | 562 | 71% |
| 1965 | 1,936 | 786 | 59% |
| 1966 | 2,106 | 1,029 | 51% |
| 1967 | 1,543 | 681 | 56% |
| 1968 | 1,510 | 615 | 59% |
| 1969 | 1,576 | 533 | 66% |
| 1970 | 1,378 | 921 | 33% |
| 1971 | 1,288 | 732 | 43% |
| 1972 | 1,553 | 687 | 56% |
| 1973 | 1,369 | 694 | 49% |

1/ Sediment Inflow based on total load computations at Adobe Ruins.

2/ Sediment Outflow computed from suspended sediment samples obtained in All-American Canal Desilting Basins, All-American Canal at Sta. 60, Gila Gravity Main Canal at Sta. 144+50 and Gila Settling Basin return to river. Does not include California Sluiceway return to river.

Table 7
SUSPENDED SEDIMENT LOAD - GRAND CANYON STATION

| Water Year Ending Sept. 30 | Discharge (1,000 ac-ft) | Load <u>1/</u> (1,000 tons) |
|----------------------------------|----------------------------|--------------------------------|
| 1926 | 14,400 | 225,000 |
| 1927 | 17,300 | 398,000 |
| 1928 | 15,600 | 172,000 |
| 1929 | 19,400 | 480,000 |
| 1930 | 13,400 | 235,400 |
| 1931 | 6,720 | 68,810 |
| 1932 | 16,000 | 261,400 |
| 1933 | 10,000 | 178,100 |
| 1934 | 4,656 | 50,080 |
| 1935 | 10,216 | 122,300 |
| 1936 | 12,322 | 157,600 |
| 1937 | 12,410 | 191,300 |
| 1938 | 15,630 | 232,400 |
| 1939 | 9,618 | 86,320 |
| 1940 | 7,435 | 75,410 |
| 1941 | 16,940 | 270,100 |
| 1942 | 17,260 | 229,600 |
| 1943 | 11,430 | 58,760 <u>2/</u> |
| 1944 | 13,530 | 97,790 |
| 1945 | 11,870 | 83,631 |
| 1946 | 9,089 | 65,970 |
| 1947 | 13,740 | 136,000 |
| 1948 | 13,870 | 144,100 |
| 1949 | 14,370 | 118,900 |
| 1950 | 11,080 | 59,780 |
| 1951 | 9,839 | 48,729 |
| 1952 | 18,160 | 148,500 |
| 1953 | 8,879 | 48,814 |
| 1954 | 6,229 | 40,674 |
| 1955 | 7,580 | 83,132 |
| 1956 | 8,860 | 76,132 |
| 1957 | 17,500 | 155,438 |
| 1958 | 14,550 | 132,495 |
| 1959 | 6,935 | 23,618 |
| 1960 | 9,584 | 39,582 |
| 1961 | 7,051 | 46,831 |
| 1962 | 15,246 | 85,603 |
| 1963 | 2,736 | 20,193 |
| 1964 | 2,727 | 20,394 |
| 1965 | 10,982 | 39,568 |
| 1966 | 8,328 | 9,053 |
| 1967 | 8,032 | 23,200 |
| 1968 | 8,936 | 16,274 |
| 1969 | 9,283 | 14,405 |
| 1970 | 9,120 | 12,611 |
| 1971 | 8,837 | 18,115 |
| 1972 <u>3/</u> | 9,540 | 14,802 |

1/ From U.S. Geological Survey Water Supply Papers 1926-1942, 1944-1969.

2/ Estimated by applying mean monthly concentrations of suspended sediment in the Colorado River at Lees Ferry gaging station to discharge at Grand Canyon.

3/ Station discontinued September 1972.

TABLE 8
SUSPENDED SEDIMENT CONCENTRATIONS
BELOW DAVIS DAM

| Station | RS 33 | Needles Bridge | RS #1 | RS 43 |
|-----------------------|--------|---------------------------|-------|-------|
| Miles Below Davis Dam | 25.3 | 33.2 | 45.3 | 50.3 |
| <hr/> | | | | |
| Year | Mean Q | Mean Concentration in PPM | | |
| 1/ | | | | |
| 1956 | 11,000 | 232 | 249 | 131 |
| 1957 | 10,500 | 222 | 243 | 105 |
| 1958 | 16,500 | 323 | 310 | 325 |
| 1959 | 12,700 | - | 392 | 167 |
| 1960 | 12,100 | - | 222 | 118 |
| 1961 | 11,500 | - | 87 | 83 |
| 1962 | 11,700 | - | 101 | 72 |
| 1963 | 11,800 | - | 92 | 64 |
| 1964 | 11,000 | - | 66 | 47 |
| 1965 | 10,500 | - | 58 | 50 |
| 1966 | 11,000 | - | 60 | 41 |
| 1967 | 10,500 | - | 86 | 50 |
| 1968 | 10,800 | - | 86 | 28 |
| 1969 | 10,700 | - | 79 | 33 |
| 1970 | 10,700 | - | 88 | 36 |
| 1971 | 11,000 | - | 68 | 23 |
| 1972 | 10,700 | - | 70 | 24 |
| 1973 | 10,700 | - | 68 | 26 |

1/ For years prior to 1956 see Table 2 of "Report of River Control Works and Investigations, Lower Colorado River Basin" Calendar Years 1952 through 1956.

TABLE 9
SUSPENDED SEDIMENT CONCENTRATIONS

BELOW PARKER DAM

| <u>Station</u> | <u>Water Wheel</u> | <u>Below P.V.I.D.</u> | <u>Taylor Ferry</u> | <u>Adobe Ruins</u> | <u>4S Ranch</u> |
|----------------|----------------------------------|-----------------------|---------------------|--------------------|-----------------|
| <u>Year</u> | <u>Mean Concentration in PPM</u> | | | | |
| 1968 | 47 | 84 | 170 | 123 | |
| 1969 | 75 | 89 | 244 | 129 | |
| 1970 | 100 | 83 | 231 | 143 | |
| 1971 | 98 | 83 | 148 | 74 | |
| 1972 | 62 | 81 | 150 | 103 | 75 |
| <u>1973</u> | <u>73</u> | <u>81</u> | <u>144</u> | <u>100</u> | <u>72</u> |

TABLE 10
SUSPENDED-SEDIMENT LOAD - YUMA GAGING STATION

| Calendar Year | Discharge in Thousands of Acre-Feet | Load in Thousands of Tons | Average Parts Per Million | No. of Samples From Which Determined |
|---------------|-------------------------------------|---------------------------|---------------------------|--------------------------------------|
| 1911 | 17,800 | 250,700 | 10,363 | 52 to 66 |
| 1912 | 18,400 | 187,900 | 7,514 | 52 to 66 |
| 1913 | 11,700 | 119,600 | 7,522 | 52 to 66 |
| 1914 | 20,700 | 265,400 | 9,434 | 94 to 105 |
| 1915 | 14,600 | 235,300 | 11,858 | 94 to 105 |
| 1916 | 23,100 | 348,700 | 11,107 | 94 to 105 |
| 1917 | 20,600 | 160,300 | 5,726 | 94 to 105 |
| 1918 | 13,200 | 112,900 | 6,293 | 94 to 105 |
| 1919 | 10,700 | 154,000 | 10,590 | 94 to 105 |
| 1920 | 21,400 | 220,800 | 7,592 | 94 to 105 |
| 1921 | 19,400 | 221,700 | 8,409 | 94 to 105 |
| 1922 | 17,000 | 192,500 | 8,332 | 94 to 105 |
| 1923 | 17,800 | 250,300 | 10,347 | 94 to 105 |
| 1924 | 11,300 | 127,500 | 8,302 | 94 to 105 |
| 1925 | 12,400 | 163,200 | 9,684 | 94 to 105 |
| 1926 | 12,200 | 130,800 | 7,889 | 94 to 105 |
| 1927 | 17,100 | 242,500 | 10,435 | 94 to 105 |
| 1928 | 12,800 | 114,800 | 6,599 | 94 to 105 |
| 1929 | 17,500 | 289,000 | 12,151 | 94 to 105 |
| 1930 | 10,600 | 183,900 | 12,765 | 94 to 105 |
| 1931 | 4,800 | 52,100 | 7,987 | 94 to 105 |
| 1932 | 14,200 | 184,200 | 9,545 | 94 to 105 |
| 1933 | 8,000 | 92,200 | 8,480 | 94 to 105 |
| 1934 | 2,400 | 17,800 | 5,457 | Not Known |
| 1935 | 4,000 | 21,600 | 3,973 | 63 |
| 1936 | 3,500 | 14,000 | 2,943 | 99 to 105 |
| 1937 | 4,000 | 15,800 | 2,906 | 99 to 105 |
| 1938 | 4,200 | 12,500 | 2,190 | 99 to 105 |
| 1939 | 6,600 | 13,000 | 1,449 | 26 |
| 1940 | 5,400 | 3,500 | 477 | 28 |
| 1941 | 11,700 | 14,100 | 887 | 31 |
| 1942 | 10,500 | 8,800 | 617 | 18 |
| 1943 | 7,300 | 3,000 | 302 | 21 |
| 1944 | 8,600 | 4,800 | 411 | 21 |
| 1945 | 6,500 | 4,400 | 498 | 18 |

TABLE 10 (Continued)
SUSPENDED-SEDIMENT LOAD - YUMA GAGING STATION

| Calendar Year | Discharge in Thousands of Acre-Feet | Load in Thousands of Tons | Average Parts Per Million | No. of Samples from Which Determined |
|--------------------|-------------------------------------|---------------------------|---------------------------|--------------------------------------|
| 1946 | 3,800 | 1,700 | 329 | 19 |
| 1947 | 4,200 | 2,000 | 350 | 22 |
| 1948 | 6,300 | 6,700 | 738 | 22 |
| 1949 | 6,600 | 7,800 | 870 | 12 |
| 1950 | 3,500 | 3,500 | 736 | 54 |
| 1951 | 2,800 | 1,100 | 289 | 147 |
| 1952 | 9,200 | 10,500 | 840 | 143 |
| 1953 | 4,100 | 1,900 | 341 | 175 |
| 1954 | 3,200 | 1,300 | 299 | 168 |
| 1955 | 2,100 | 828 | 290 | 155 |
| 1956 | 881 | 264 | 220 | 155 |
| 1957 | 1,171 | 656 | 412 | 156 |
| 1958 | 2,945 | 3,940 | 984 | 253 |
| 1959 | 935 | 561 | 441 | 142 |
| 1960 | 703 | 260 | 199 | 115 |
| 1961 | 682 | 162 | 174 | 104 |
| 1962 | 861 | 527 | 450 | 129 |
| 1963 | 926 | 296 | 235 | 103 |
| 1964 | 723 | 154 | 157 | 108 |
| 1965 | 704 | 202 | 211 | 61 |
| 1966 | 427 | 70 | 121 | 102 |
| 1967 | 353 | 39 | 81 | 103 |
| 1968 | 405 | 76 | 138 | 106 |
| 1969 | 365 | 54 | 109 | 103 |
| 1970 | 347 | 32 | 68 | 90 |
| 1971 | 370 | 40 | 80 | 24 |
| 1972 | 360 | 47 | 95 | 24 |
| 1973 ^{1/} | 634 | 125 | 143 | 22 |

Yuma - type Sampler used from 1911 through 1938.

Tait-Brinkley Sampler used from 1939 through September 30, 1947.

D-43 Sampler used after September 30, 1947.

^{1/}Sampling point moved to USGS gage below Yuma Main Canal Wasteway.

TABLE 11
SUSPENDED SEDIMENT LOAD NORTHERLY INTERNATIONAL BOUNDARY
TONS

| Month | Records Computed by IBWC | | | | | | 1973 | | | |
|------------------------------|--------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | | | | |
| Jan. | 16,400 | 4,400 | 3,100 | 4,000 | 4,500 | 10,800 | 7,400 | 5,600 | 6,200 | 4,300 |
| Feb. | 21,200 | 6,100 | 12,400 | 6,100 | 4,800 | 6,700 | 7,800 | 7,100 | 6,200 | 7,200 |
| Mar. | 53,600 | 47,000 | 43,900 | 28,400 | 18,700 | 22,000 | 40,400 | 28,600 | 19,400 | 25,600 |
| Apr. | 24,000 | 36,600 | 23,200 | 17,600 | 28,200 | 19,800 | 25,600 | 17,500 | 18,400 | 14,500 |
| May | 7,400 | 7,100 | 5,000 | 7,100 | 6,700 | 6,000 | 7,800 | 4,200 | 4,300 | 12,700 |
| June | 12,000 | 9,400 | 9,800 | 12,800 | 9,200 | 10,800 | 9,000 | 13,300 | 8,200 | 24,600 |
| July | 35,500 | 13,700 | 23,200 | 19,200 | 16,700 | 14,000 | 14,100 | 16,100 | 11,200 | 15,700 |
| Aug. | 23,600 | 14,600 | 28,600 | 20,300 | 16,600 | 11,400 | 14,900 | 29,200 | 17,000 | 13,600 |
| Sept. | 7,400 | 9,200 | 11,300 | 10,700 | 5,900 | 5,100 | 4,300 | 7,100 | 13,000 | 4,100 |
| Oct. | 3,200 | 1,500 | 7,500 | 1,900 | 2,400 | 2,800 | 2,100 | 3,200 | 3,200 | 2,600 |
| Nov. | 4,400 | 5,500 | 2,000 | 2,100 | 2,300 | 6,400 | 1,400 | 1,000 | 1,500 | 1,700 |
| Dec. | 3,600 | 13,100 | 4,700 | 2,500 | 3,500 | 3,800 | 5,900 | 6,000 | 20,300 | 8,200 |
| Yearly | 212,300 | 168,200 | 174,700 | 132,700 | 119,500 | 119,600 | 140,700 | 138,900 | 109,300 | 134,800 |
| Avg. % Concen- tration | 0.0104 | 0.0081 | 0.0074 | 0.0074 | 0.0066 | 0.0067 | 0.0079 | 0.0078 | 0.0060 | 0.0074 |

TABLE 12

TOTAL SEDIMENT LOAD
COLORADO RIVER BELOW NEEDLES BRIDGE

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-21-72 | 8,879 | 17 | 398 | 1,145 | 68.1 |
| 2 | 2-9-72 | 6,037 | 19 | 311 | 826 | 62.3 |
| 3 | 2-23-72 | 8,777 | 13 | 313 | 791 | 60.4 |
| 4 | 3-8-72 | 9,067 | 59 | 1,437 | 2,501 | 42.5 |
| 5 | 4-4-72 | 9,545 | 19 | 500 | 1,075 | 53.5 |
| 6 | 4-18-72 | 9,200 | 13 | 323 | 703 | 54.1 |
| 7 | 5-4-72 | 14,500 | 37 | 1,460 | 3,226 | 54.7 |
| 8 | 5-23-72 | 8,220 | 236 | 5,241 | 6,399 | 22.1 |
| 9 | 6-15-72 | 6,270 | 40 | 677 | 863 | 21.6 |
| 10 | 6-27-72 | 8,550 | 22 | 497 | 1,224 | 59.4 |
| 11 | 7-13-72 | 15,300 | 85 | 3,492 | 6,209 | 43.8 |
| 12 | 7-25-72 | 9,260 | 82 | 2,053 | 8,524 | 75.9 |
| 13 | 8-22-72 | 11,200 | 36 | 1,093 | 2,347 | 53.4 |
| 14 | 9-12-72 | 7,732 | 137 | 2,860 | 5,110 | 44.0 |
| 15 | 11-15-72 | 5,360 | 36 | 527 | 1,287 | 59.1 |
| 16 | 11-29-72 | 6,260 | 119 | 2,019 | 3,981 | 49.3 |

TABLE 12 (Continued)

TOTAL SEDIMENT LOAD
COLORADO RIVER BELOW NEEDLES BRIDGE

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-19-73 | 4,890 | 39 | 520 | 523 | 36.8 |
| 2 | 3-8-73 | 13,800 | 104 | 3,875 | 6,592 | 41.2 |
| 3 | 3-23-73 | 13,500 | 123 | 4,483 | 7,303 | 38.6 |
| 4 | 4-6-73 | 16,100 | 103 | 4,477 | 7,458 | 40.0 |
| 5 | 4-25-73 | 13,500 | 72 | 2,624 | 4,699 | 44.2 |
| 6 | 5-11-73 | 13,800 | 84 | 3,130 | 5,706 | 45.1 |
| 7 | 5-25-73 | 12,600 | 34 | 1,157 | 2,978 | 61.1 |
| 8 | 6-29-73 | 14,540 | 132 | 5,195 | 8,574 | 39.4 |
| 9 | 7-12-73 | 13,090 | 64 | 2,279 | 4,672 | 51.2 |
| 10 | 8-7-73 | 12,080 | 266 | 8,677 | 12,743 | 31.9 |
| 11 | 8-21-73 | 7,920 | 267 | 5,714 | 8,159 | 30.0 |
| 12 | 10-30-73 | 5,615 | 12 | 174 | 481 | 63.8 |
| 13 | 11-13-73 | 6,090 | 232 | 3,811 | 5,016 | 24.0 |

TABLE 13
TOTAL SEDIMENT LOAD
COLORADO RIVER AT R.S. 41

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 2-9-72 | 11,600 | 10 | 320 | 708 | 54.8 |
| 2 | 2-24-72 | 10,800 | 19 | 558 | 762 | 26.8 |
| 3 | 3-9-72 | 14,100 | 26 | 1,006 | 1,531 | 34.3 |
| 4 | 3-22-72 | 15,700 | 36 | 1,514 | 2,027 | 25.3 |
| 5 | 4-5-72 | 15,400 | 41 | 1,713 | 2,162 | 20.8 |
| 6 | 4-20-72 | 15,200 | 36 | 1,471 | 2,199 | 33.1 |
| 7 | 5-3-72 | 14,600 | 30 | 1,182 | 1,821 | 35.1 |
| 8 | 5-24-72 | 11,200 | 9 | 276 | 419 | 34.1 |
| 9 | 6-28-72 | 12,700 | 40 | 1,367 | 1,731 | 21.0 |
| 10 | 7-12-72 | 13,400 | 42 | 1,508 | 1,921 | 21.5 |
| 11 | 7-26-72 | 15,700 | 54 | 2,289 | 3,183 | 28.1 |
| 12 | 8-9-72 | 14,800 | 37 | 1,468 | 2,110 | 30.4 |
| 13 | 8-23-72 | 13,700 | 67 | 2,468 | 3,226 | 23.5 |
| 14 | 9-13-72 | 13,600 | 36 | 1,327 | 2,020 | 34.3 |
| 15 | 11-16-72 | 6,890 | 19 | 353 | 401 | 12.0 |
| 16 | 11-30-72 | 8,460 | 33 | 749 | 870 | 13.9 |
| 17 | 12-14-72 | 8,350 | 28 | 624 | 739 | 15.6 |

TABLE 13 (Continued)

TOTAL SEDIMENT LOAD
COLORADO RIVER AT R.S. 41

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 3-7-73 | 13,400 | 149 | 5,402 | 6,693 | 19.3 |
| 2 | 3-22-73 | 13,000 | 91 | 3,194 | 4,327 | 26.2 |
| 3 | 4-5-73 | 14,900 | 88 | 3,540 | 5,236 | 32.4 |
| 4 | 4-26-73 | 15,400 | 53 | 2,204 | 3,188 | 30.9 |
| 5 | 5-10-73 | 14,000 | 21 | 794 | 1,575 | 49.6 |
| 6 | 5-24-73 | 12,400 | 103 | 3,448 | 4,788 | 28.0 |
| 7 | 6-28-73 | 14,700 | 93 | 3,689 | 5,081 | 27.4 |
| 8 | 7-11-73 | 15,340 | 38 | 1,583 | 2,220 | 71.3 |
| 9 | 8-9-73 | 16,360 | 37 | 1,620 | 3,147 | 48.5 |
| 10 | 9-6-73 | 12,300 | 110 | 3,663 | 4,392 | 16.6 |
| 11 | 10-17-73 | 14,300 | 89 | 3,425 | 4,249 | 19.4 |
| 12 | 12-5-73 | 9,770 | 49 | 1,303 | 1,629 | 20.0 |

TABLE 14

TOTAL SEDIMENT LOAD
COLORADO RIVER AT R.S. 43

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-19-72 | 7,060 | 45 | 863 | 1,108 | 22.1 |
| 2 | 2-9-72 | 13,700 | 44 | 1,638 | 2,972 | 44.9 |
| 3 | 2-24-72 | 12,400 | 30 | 1,012 | 2,008 | 49.6 |
| 4 | 3-9-72 | 15,800 | 76 | 3,223 | 4,944 | 34.8 |
| 5 | 3-22-72 | 17,400 | 67 | 3,143 | 5,132 | 38.8 |
| 6 | 4-5-72 | 18,700 | 45 | 2,262 | 3,972 | 48.1 |
| 7 | 4-20-72 | 17,900 | 47 | 2,272 | 3,673 | 38.1 |
| 8 | 5-3-72 | 16,500 | 74 | 3,296 | 5,380 | 38.7 |
| 9 | 5-24-72 | 11,500 | 16 | 485 | 659 | 26.4 |
| 10 | 6-28-72 | 14,800 | 55 | 2,211 | 3,029 | 27.0 |
| 11 | 7-12-72 | 16,800 | 52 | 2,363 | 3,484 | 32.2 |
| 12 | 7-26-72 | 18,000 | 61 | 2,966 | 4,518 | 34.4 |
| 13 | 8-9-72 | 16,800 | 40 | 1,824 | 2,846 | 35.9 |
| 14 | 9-13-72 | 16,200 | 84 | 3,690 | 5,172 | 28.7 |
| 15 | 11-16-72 | 7,540 | 169 | 3,431 | 3,752 | 8.6 |
| 16 | 11-30-72 | 9,310 | 64 | 1,620 | 2,072 | 21.8 |
| 17 | 12-14-72 | 8,900 | 79 | 1,909 | 2,480 | 23.0 |

TABLE 14 (Coninuted)

TOTAL SEDIMENT LOAD
COLORADO RIVER AT R.S. 43

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-18-73 | 4,750 | 14 | 183 | 198 | 7.6 |
| 2 | 3-22-73 | 14,400 | 188 | 7,309 | 9,313 | 21.5 |
| 3 | 4-5-73 | 15,500 | 135 | 5,650 | 7,588 | 25.5 |
| 4 | 5-10-73 | 16,100 | 51 | 2,217 | 3,415 | 35.1 |
| 5 | 6-28-73 | 16,800 | 105 | 4,757 | 6,244 | 23.8 |
| 6 | 7-11-73 | 16,430 | 68 | 2,999 | 4,240 | 29.3 |
| 7 | 8-23-73 | 10,665 | 20 | 579 | 732 | 20.9 |
| 8 | 9-12-73 | 16,280 | 319 | 14,012 | 17,454 | 19.7 |
| 9 | 10-17-73 | 14,600 | 97 | 3,817 | 4,839 | 21.1 |
| 10 | 10-31-73 | 10,400 | 69 | 1,936 | 2,253 | 14.1 |
| 11 | 11-14-73 | 9,810 | 33 | 878 | 1,121 | 21.7 |

TABLE 15

TOTAL SEDIMENT LOAD
COLORADO RIVER AT WATER WHEEL

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-14-72 | 4,400 | 37 | 445 | 3,310 | 86.6 |
| 2 | 1-28-72 | 4,970 | 18 | 246 | 453 | 45.7 |
| 3 | 2-4-72 | 4,860 | 11 | 150 | 381 | 60.6 |
| 4 | 2-17-72 | 6,130 | 30 | 491 | 1,200 | 59.1 |
| 5 | 3-2-72 | 6,085 | 56 | 921 | 1,561 | 41.0 |
| 6 | 3-15-72 | 9,710 | 53 | 1,403 | 2,659 | 47.2 |
| 7 | 3-31-72 | 8,670 | 81 | 1,906 | 3,452 | 44.8 |
| 8 | 4-28-72 | 6,600 | 14 | 245 | 551 | 55.5 |
| 9 | 5-11-72 | 8,330 | 23 | 517 | 1,036 | 50.1 |
| 10 | 6-6-72 | 12,000 | 52 | 1,701 | 2,893 | 41.2 |
| 11 | 6-25-72 | 10,600 | 55 | 1,571 | 2,874 | 45.3 |
| 12 | 7-21-72 | 7,330 | 51 | 1,017 | 1,476 | 31.1 |
| 13 | 12-20-72 | 4,780 | 210 | 2,713 | 4,705 | 42.3 |

TABLE 16

TOTAL SEDIMENT LOAD
COLORADO RIVER BELOW PALO VERDE DAM

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-14-72 | 4,575 | 105 | 1,292 | 1,838 | 29.7 |
| 2 | 1-28-72 | 5,520 | 123 | 1,840 | 3,032 | 39.3 |
| 3 | 2-4-72 | 6,725 | 103 | 1,871 | 2,889 | 35.2 |
| 4 | 2-17-72 | 8,570 | 91 | 2,108 | 3,603 | 41.5 |
| 5 | 3-2-72 | 8,950 | 78 | 1,880 | 3,929 | 52.2 |
| 6 | 3-15-72 | 12,500 | 177 | 5,986 | 9,456 | 36.7 |
| 7 | 3-31-72 | 11,000 | 103 | 3,063 | 4,911 | 37.6 |
| 8 | 4-28-72 | 9,480 | 642 | 16,437 | 20,762 | 20.8 |
| 9 | 5-11-72 | 10,800 | 317 | 9,249 | 12,659 | 26.9 |
| 10 | 6-6-72 | 11,900 | 92 | 2,943 | 4,216 | 30.2 |
| 11 | 6-27-72 | 13,400 | 132 | 4,785 | 6,624 | 27.8 |
| 12 | 7-21-72 | 10,700 | 55 | 1,600 | 2,874 | 44.3 |
| 13 | 11-7-72 | 6,710 | 46 | 840 | 1,499 | 44.0 |
| 14 | 12-20-72 | 5,160 | 26 | 366 | 737 | 50.3 |

TABLE 16 (Continued)

TOTAL SEDIMENT LOAD
COLORADO RIVER BELOW PALO VERDE DAM

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-31-73 | 7,490 | 280 | 5,656 | 10,091 | 44.0 |
| 2 | 2-27-73 | 5,972 | 86 | 1,384 | 2,704 | 48.8 |
| 3 | 3-28-73 | 13,600 | 232 | 8,519 | 13,697 | 37.8 |
| 4 | 4-11-73 | 14,600 | 203 | 8,002 | 12,465 | 35.8 |
| 5 | 7-13-73 | 12,000 | 79 | 2,544 | 4,802 | 47.0 |
| 6 | 8-16-73 | 12,520 | 97 | 3,292 | 6,748 | 51.2 |
| 7 | 9-21-73 | 7,385 | 31 | 610 | 1,069 | 42.9 |
| 8 | 10-5-73 | 9,575 | 201 | 5,205 | 7,463 | 30.3 |
| 9 | 12-13-73 | 6,260 | 136 | 2,301 | 3,155 | 27.1 |

TABLE 17

TOTAL SEDIMENT LOAD
COLORADO RIVER AT TAYLOR FERRY

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-11-72 | 6,110 | 95 | 1,570 | 2,761 | 43.1 |
| 2 | 1-25-72 | 4,230 | 48 | 553 | 1,247 | 55.7 |
| 3 | 2-15-72 | 8,100 | 101 | 2,218 | 4,050 | 45.2 |
| 4 | 2-29-72 | 6,330 | 94 | 1,614 | 3,571 | 54.8 |
| 5 | 3-14-72 | 7,200 | 80 | 1,555 | 3,142 | 50.7 |
| 6 | 3-30-72 | 9,595 | 87 | 2,262 | 4,350 | 48.0 |
| 7 | 4-11-72 | 11,000 | 98 | 2,911 | 5,479 | 46.9 |
| 8 | 4-25-72 | 9,600 | 122 | 3,155 | 5,654 | 44.2 |
| 9 | 5-9-72 | 8,260 | 94 | 2,105 | 3,822 | 44.9 |
| 10 | 5-31-72 | 6,375 | 371 | 6,384 | 7,934 | 19.5 |
| 11 | 6-20-72 | 7,780 | 206 | 4,334 | 7,236 | 40.1 |
| 12 | 7-7-72 | 8,300 | 251 | 5,628 | 8,612 | 34.6 |
| 13 | 7-20-72 | 8,920 | 114 | 2,739 | 4,881 | 43.9 |
| 14 | 11-3-72 | 5,040 | 113 | 1,531 | 2,501 | 38.8 |
| 15 | 12-12-72 | 5,665 | 99 | 1,508 | 2,905 | 48.1 |
| 16 | 12-27-72 | 3,940 | 60 | 643 | 1,253 | 48.7 |

TABLE 17 (Continued)

TOTAL SEDIMENT LOAD
COLORADO RIVER AT TAYLOR FERRY

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-16-73 | 2,830 | 95 | 725 | 980 | 26.0 |
| 2 | 1-24-73 | 4,690 | 125 | 1,585 | 3,414 | 53.6 |
| 3 | 3-9-73 | 8,558 | 224 | 5,176 | 8,820 | 41.3 |
| 4 | 4-3-73 | 11,300 | 386 | 11,777 | 18,153 | 35.1 |
| 5 | 4-12-73 | 10,000 | 191 | 5,157 | 8,746 | 41.0 |
| 6 | 5-8-73 | 8,260 | 129 | 2,877 | 5,291 | 45.6 |
| 7 | 6-20-73 | 5,860 | 74 | 1,171 | 2,350 | 50.2 |
| 8 | 7-24-73 | 10,250 | 150 | 4,156 | 7,353 | 43.5 |
| 9 | 8-14-73 | 8,930 | 150 | 3,627 | 5,620 | 35.5 |
| 10 | 8-28-73 | 6,746 | 80 | 1,463 | 2,723 | 46.3 |
| 11 | 9-19-73 | 6,720 | 218 | 3,952 | 5,981 | 33.9 |
| 12 | 10-13-73 | 5,775 | 202 | 3,143 | 4,286 | 26.7 |
| 13 | 10-25-73 | 5,095 | 155 | 2,130 | 2,882 | 26.1 |
| 14 | 12-4-73 | 4,065 | 96 | 1,057 | 1,637 | 35.4 |
| 15 | 12-11-73 | 4,370 | 198 | 2,332 | 2,873 | 18.8 |

TABLE 18

TOTAL SEDIMENT LOAD
COLORADO RIVER AT ADOBE RUINS

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-25-72 | 5,840 | 43 | 671 | 1,028 | 34.7 |
| 2 | 2-3-72 | 6,260 | 50 | 853 | 1,102 | 22.6 |
| 3 | 2-15-72 | 8,740 | 100 | 2,352 | 3,088 | 23.8 |
| 4 | 2-29-72 | 7,300 | 94 | 1,845 | 2,305 | 20.0 |
| 5 | 3-15-72 | 9,760 | 131 | 3,456 | 4,329 | 20.2 |
| 6 | 4-12-72 | 12,000 | 232 | 7,530 | 11,064 | 31.9 |
| 7 | 4-26-72 | 11,000 | 133 | 3,950 | 5,911 | 33.2 |
| 8 | 6-1-72 | 8,676 | 56 | 1,312 | 2,251 | 41.7 |
| 9 | 7-20-72 | 10,500 | 170 | 4,808 | 7,345 | 34.5 |
| 10 | 9-20-72 | 9,200 | 170 | 4,214 | 6,514 | 35.3 |
| 11 | 11-2-72 | 6,080 | 61 | 999 | 1,675 | 40.4 |
| 12 | 12-12-72 | 7,120 | 70 | 1,349 | 2,126 | 36.5 |
| 13 | 12-27-72 | 5,500 | 38 | 567 | 917 | 38.2 |

TABLE 18 (Continued)

TOTAL SEDIMENT LOAD
COLORADO RIVER AT ADOBE RUINS

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-16-73 | 5,240 | 35 | 490 | 837 | 41.5 |
| 2 | 1-24-73 | 5,685 | 40 | 616 | 1,021 | 39.7 |
| 3 | 3-9-73 | 9,354 | 155 | 3,915 | 5,557 | 29.5 |
| 4 | 3-20-73 | 8,706 | 276 | 6,488 | 9,458 | 31.4 |
| 5 | 4-3-73 | 10,300 | 477 | 13,265 | 18,522 | 28.4 |
| 6 | 4-12-73 | 10,200 | 101 | 2,782 | 5,458 | 49.0 |
| 7 | 5-8-73 | 10,600 | 203 | 5,810 | 10,451 | 44.4 |
| 8 | 6-26-73 | 10,960 | 238 | 7,043 | 11,303 | 37.7 |
| 9 | 7-24-73 | 11,250 | 179 | 5,448 | 8,846 | 38.4 |
| 10 | 9-18-73 | 10,120 | 114 | 3,123 | 6,282 | 50.3 |
| 11 | 10-4-73 | 9,780 | 223 | 5,888 | 7,008 | 16.0 |
| 12 | 10-24-73 | 7,100 | 73 | 1,400 | 2,037 | 31.3 |
| 13 | 12-11-73 | 5,375 | 63 | 912 | 1,255 | 27.3 |

TABLE 19
TOTAL SEDIMENT LOAD
COLORADO RIVER AT 4S RANCH

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-13-72 | 8,450 | 910 | 1,763 | 2,311 | 23.7 |
| 2 | 1-26-72 | 7,700 | 72 | 1,500 | 1,787 | 16.1 |
| 3 | 2-18-72 | 10,300 | 103 | 2,852 | 3,974 | 28.2 |
| 4 | 3-1-72 | 10,400 | 61 | 1,709 | 2,276 | 24.9 |
| 5 | 3-16-72 | 13,500 | 230 | 8,394 | 10,066 | 16.6 |
| 6 | 4-12-72 | 15,700 | 72 | 3,041 | 3,760 | 19.1 |
| 7 | 4-26-72 | 12,700 | 450 | 15,427 | 16,294 | 5.3 |
| 8 | 5-10-72 | 11,700 | 94 | 2,973 | 4,144 | 28.3 |
| 9 | 6-1-72 | 10,200 | 164 | 4,528 | 6,901 | 34.4 |
| 10 | 6-21-72 | 12,350 | 158 | 5,272 | 6,957 | 24.2 |
| 11 | 9-6-72 | 9,800 | 55 | 1,455 | 2,118 | 31.3 |
| 12 | 9-20-72 | 11,600 | 170 | 5,313 | 6,601 | 19.5 |
| 13 | 12-14-72 | 8,010 | 67 | 1,455 | 2,248 | 35.3 |

TABLE 19 (Continued)

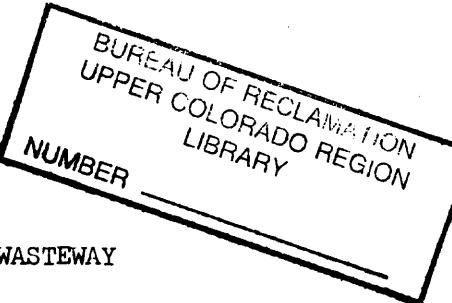
TOTAL SEDIMENT LOAD
COLORADO RIVER AT 4S RANCH

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 3-1-73 | 7,767 | 202 | 4,242 | 5,270 | 19.5 |
| 2 | 3-29-73 | 15,000 | 269 | 10,899 | 13,662 | 20.2 |
| 3 | 9-20-73 | 11,970 | 235 | 7,589 | 8,710 | 12.9 |
| 4 | 12-12-73 | 7,285 | 257 | 5,055 | 5,947 | 15.0 |

TABLE 20
TOTAL SEDIMENT LOAD
COLORADO RIVER BELOW YUMA MAIN CANAL WASTEWAY

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 2-25-72 | 464 | 51 | 64 | 180 | 64.4 |
| 2 | 3-10-72 | 505 | 77 | 105 | 204 | 48.5 |
| 3 | 3-24-72 | 539 | 90 | 131 | 259 | 49.4 |
| 4 | 4-7-72 | 577 | 83 | 129 | 262 | 50.8 |
| 5 | 4-21-72 | 527 | 73 | 104 | 149 | 30.2 |
| 6 | 5-19-72 | 293 | 59 | 47 | 55 | 14.5 |
| 7 | 6-9-72 | 444 | 26 | 31 | 103 | 69.9 |
| 8 | 6-27-72 | 524 | 77 | 109 | 170 | 35.9 |
| 9 | 7-14-72 | 500 | 74 | 100 | 153 | 34.6 |
| 10 | 7-27-72 | 524 | 77 | 109 | 158 | 31.0 |
| 11 | 8-11-72 | 860 | 121 | 281 | 574 | 51.0 |
| 12 | 8-25-72 | 530 | 63 | 90 | 132 | 31.8 |
| 13 | 9-22-72 | 518 | 77 | 108 | 153 | 29.4 |
| 14 | 10-31-72 | 577 | 276 | 430 | 603 | 28.7 |
| 15 | 11-17-72 | 577 | 76 | 118 | 233 | 49.4 |
| 16 | 11-29-72 | 393 | 67 | 71 | 86 | 17.4 |
| 17 | 12-15-72 | 487 | 74 | 97 | 214 | 54.7 |
| 18 | 12-27-72 | 526 | 48 | 68 | 155 | 56.1 |

TABLE 20 (Continued)

TOTAL SEDIMENT LOAD
COLORADO RIVER BELOW YUMA MAIN CANAL WASTEWAY

| Sample No. | Date | Discharge (cfs) | Suspended Concentration (ppm) | Measured Load (Tons/Day) | Computed Total Load (Tons/Day) | Percent Unmeasured Load |
|------------|----------|-----------------|-------------------------------|--------------------------|--------------------------------|-------------------------|
| 1 | 1-10-73 | 516 | 73 | 102 | 147 | 30.6 |
| 2 | 1-24-73 | 745 | 57 | 115 | 276 | 58.3 |
| 3 | 2-7-73 | 1,010 | 91 | 248 | 609 | 59.3 |
| 4 | 2-21-73 | 529 | 33 | 47 | 69 | 31.9 |
| 5 | 3-7-73 | 484 | 67 | 88 | 128 | 31.3 |
| 6 | 3-29-73 | 620 | 68 | 114 | 277 | 58.8 |
| 7 | 4-11-73 | 565 | 81 | 124 | 290 | 57.2 |
| 8 | 4-25-73 | 606 | 92 | 151 | 362 | 58.3 |
| 9 | 5-9-73 | 1,020 | 648 | 1,785 | 2,876 | 37.9 |
| 10 | 5-30-73 | 1,330 | 316 | 1,135 | 1,894 | 40.1 |
| 11 | 6-6-73 | 1,470 | 762 | 3,024 | 5,369 | 43.7 |
| 12 | 6-20-73 | 1,740 | 200 | 940 | 1,449 | 35.1 |
| 13 | 7-5-73 | 695 | 217 | 407 | 672 | 39.4 |
| 14 | 7-18-73 | 670 | 81 | 147 | 268 | 45.1 |
| 15 | 9-12-73 | 655 | 112 | 198 | 252 | 21.4 |
| 16 | 9-26-73 | 1,120 | 61 | 184 | 617 | 70.2 |
| 17 | 10-10-73 | 1,140 | 57 | 175 | 606 | 71.1 |
| 18 | 10-24-73 | 625 | 33 | 56 | 177 | 68.4 |
| 19 | 11-7-73 | 524 | 37 | 52 | 134 | 61.2 |
| 20 | 11-21-73 | 1,030 | 60 | 167 | 579 | 71.2 |
| 21 | 12-5-73 | 460 | 80 | 99 | 120 | 17.5 |
| 22 | 12-27-73 | 440 | 38 | 45 | 94 | 52.1 |

TABLE 21
TOTAL YEARLY SEDIMENT LOAD-BELOW DAVIS DAM

NEEDLES BRIDGE

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 11,000 | 1,334 | 123 |
| 1965 | 10,500 | 1,316 | 127 |
| 1966 | 11,000 | 1,427 | 132 |
| 1967 | 10,500 | 1,667 | 161 |
| 1968 | 10,800 | 1,709 | 159 |
| 1969 | 10,700 | 1,493 | 141 |
| 1970 | 10,700 | 1,544 | 146 |
| 1971 | 11,000 | 1,055 | 97 |
| 1972 | 10,700 | 1,224 | 115 |
| 1973 | 10,700 | 1,529 | 144 |

RS 41

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 11,000 | 699 | 64 |
| 1965 | 10,500 | 722 | 70 |
| 1966 | 11,000 | 612 | 57 |
| 1967 | 10,500 | 483 | 46 |
| 1968 | 10,800 | 473 | 44 |
| 1969 | 10,700 | 550 | 52 |
| 1970 | 10,700 | 579 | 55 |
| 1971 | 11,000 | 364 | 34 |
| 1972 | 10,700 | 405 | 38 |
| 1973 | 10,700 | 386 | 36 |

TABLE 21 (Continued)
TOTAL YEARLY SEDIMENT LOAD-BELOW DAVIS DAM

RS 43

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 11,000 | 927 | 85 |
| 1965 | 10,500 | 901 | 87 |
| 1966 | 11,000 | 868 | 80 |
| 1967 | 10,500 | 644 | 62 |
| 1968 | 10,800 | 654 | 61 |
| 1969 | 10,700 | 652 | 61 |
| 1970 | 10,700 | 769 | 73 |
| 1971 | 11,000 | 740 | 68 |
| 1972 | 10,700 | 507 | 48 |
| 1973 | 10,700 | 507 | 48 |

TABLE 22
TOTAL YEARLY SEDIMENT LOAD-BELOW PARKER DAM

WATER WHEEL

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 8,370 | 1,184 | 143 |
| 1965 | 7,990 | 1,026 | 130 |
| 1966 | 7,940 | 698 | 89 |
| 1967 | 7,340 | 1,131 | 155 |
| 1968 | 7,220 | 1,760 | 246 |
| 1969 | 7,380 | 1,058 | 144 |
| 1970 | 7,990 | 1,178 | 149 |
| 1971 | 8,200 | 1,293 | 159 |
| 1972 | 8,100 | 786 | 98 |
| 1973 | 8,000 | 858 | 108 |

BELOW P.V.I.D.

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 7,270 | 1,128 | 157 |
| 1965 | 7,220 | 1,035 | 145 |
| 1966 | 7,490 | 1,040 | 141 |
| 1967 | 7,240 | 1,322 | 184 |
| 1968 | 7,449 | 1,922 | 260 |
| 1969 | 7,080 | 1,194 | 170 |
| 1970 | 7,290 | 1,608 | 223 |
| 1971 | 7,390 | 1,241 | 169 |
| 1972 | 7,200 | 1,217 | 170 |
| 1973 | 7,490 | 1,270 | 168 |

TABLE 22 (Continued)
TOTAL YEARLY SEDIMENT LOAD-BELOW PARKER DAM

TAYLOR FERRY

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 7,740 | 1,711 | 224 |
| 1965 | 6,920 | 1,470 | 215 |
| 1966 | 7,430 | 2,238 | 305 |
| 1967 | 7,140 | 2,469 | 348 |
| 1968 | 7,240 | 2,277 | 317 |
| 1969 | 7,150 | 2,900 | 409 |
| 1970 | 7,440 | 2,951 | 400 |
| 1971 | 7,780 | 2,424 | 314 |
| 1972 | 7,550 | 2,521 | 337 |
| 1973 | 7,510 | 2,321 | 321 |

ADOBE RUINS

| Year | Mean Q (cfs) | Sediment Load (1,000 Tons) | (ppm) |
|------|-----------------|-------------------------------|-------|
| 1964 | 8,160 | 1,944 | 240 |
| 1965 | 7,970 | 1,936 | 245 |
| 1966 | 8,160 | 2,106 | 260 |
| 1967 | 7,840 | 1,543 | 198 |
| 1968 | 7,980 | 1,510 | 191 |
| 1969 | 7,970 | 1,576 | 199 |
| 1970 | 8,040 | 1,378 | 173 |
| 1971 | 8,190 | 1,288 | 159 |
| 1972 | 7,870 | 1,553 | 199 |
| 1973 | 7,990 | 1,369 | 172 |

TABLE 22 (Continued)

TOTAL YEARLY SEDIMENT LOAD - BELOW PARKER DAM

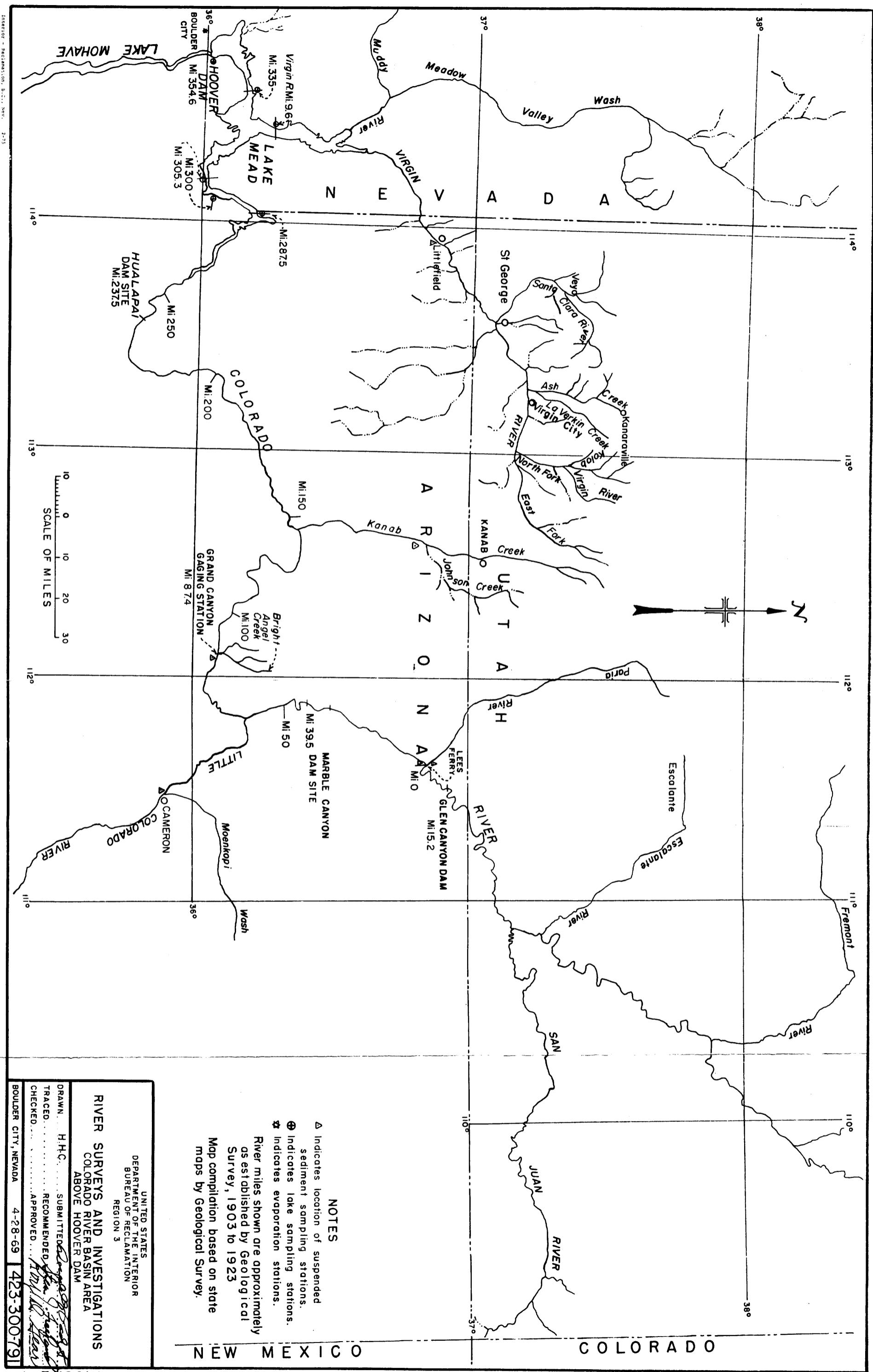
| 4S RANCH, R.M. 632.6 | | | |
|----------------------|-----------------|-------------------------------|-------|
| Year | Mean Q (cfs) | Sediment Load (1,000 tons) | (PPM) |
| 1972 | 7870 | 909 | 116 |
| 1973 | 7990 | 889 | 112 |

TABLE 23
MAJOR DIVERSSIONS FROM THE COLORADO RIVER

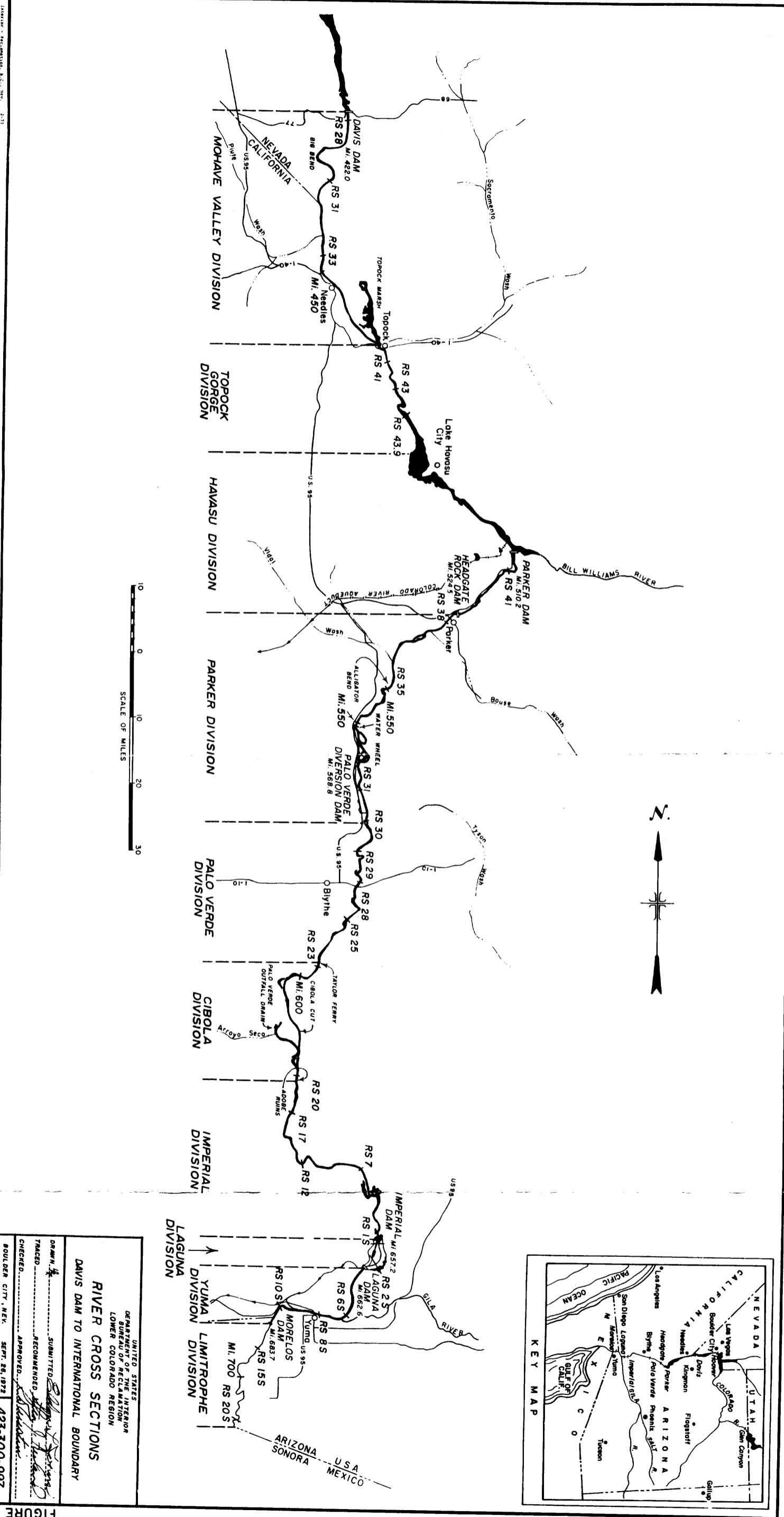
| Agency | Net Diversions ^{1/} | | | | | 1973 |
|---|------------------------------|---------|---------|---------|---------|---------|
| | 1968 | 1969 | 1970 | 1971 | 1972 | |
| Metropolitan Water District | 1,181.5 | 1,128.6 | 1,200.4 | 1,212.0 | 1,212.0 | 1,170.1 |
| Colorado River Indian Reservation | 232.3 | 218.6 | 228.2 | 297.2 | 269.2 | 308.6 |
| Palo Verde Irrigation District | 393.5 | 393.7 | 410.1 | 458.6 | 439.6 | 465.2 |
| North Gila Valley Irrigation District | 41.0 | 40.4 | 44.9 | 45.0 | 44.7 | 49.4 |
| Yuma Irrigation District | 46.2 | 53.7 | 50.1 | 51.8 | 53.5 | 55.4 |
| Wellton-Mohawk Irrigation and Drainage District | 261.8 | 283.4 | 297.3 | 318.9 | 293.5 | 371.6 |
| Yuma Mesa Irrigation and Drainage District | 255.0 | 243.8 | 259.8 | 251.3 | 229.8 | 230.3 |
| Unit B Irrigation and Drainage District | 39.4 | 37.5 | 40.2 | 40.8 | 34.5 | 37.5 |
| Yuma County Water Users' Association | 183.2 | 163.8 | 168.6 | 179.2 | 189.0 | 222.9 |
| Reservation Division, Yuma Project | 95.4 | 86.0 | 88.9 | 88.5 | 86.3 | 88.3 |
| Imperial Irrigation District | 2,895.5 | 2,766.9 | 2,848.6 | 2,932.5 | 2,965.9 | 3,047.9 |
| Coachella Valley County Water District | 478.6 | 495.1 | 449.3 | 464.4 | 511.5 | 522.4 |

^{1/} Rounded to the nearest 100 acre-feet (1973 data is provisional).

FIGURES



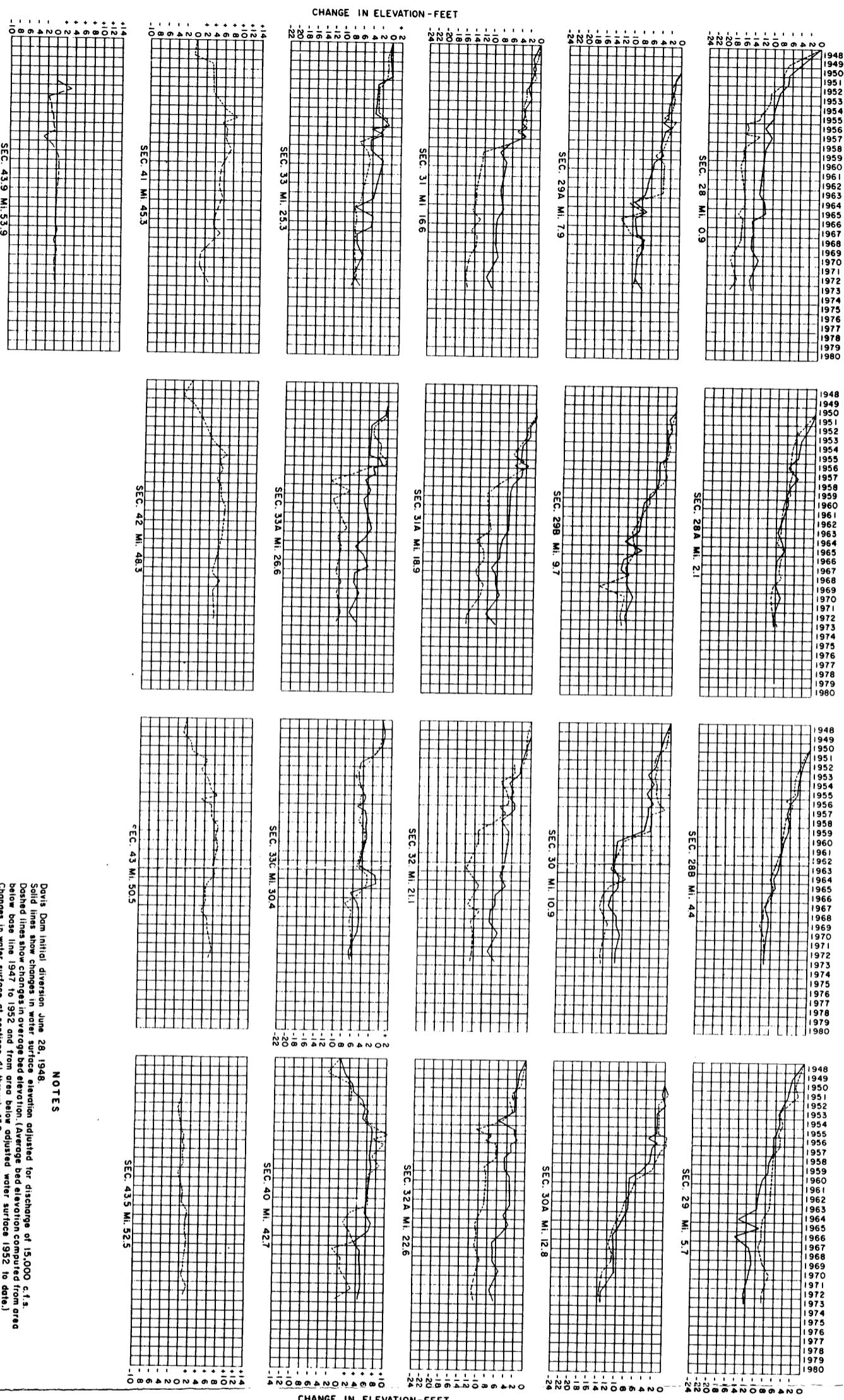
| |
|---|
| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 |
| RIVER SURVEYS AND INVESTIGATIONS COLORADO RIVER BASIN AREA ABOVE HOOVER DAM |
| DRAWN ... H.H.C. ... SUBMITTED ... <i>[Signature]</i> |
| TRACED ... RECOMMENDED ... <i>[Signature]</i> |
| CHECKED ... APPROVED ... <i>[Signature]</i> |
| BOULDER CITY, NEVADA 4-28-69 423-300791 |



| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION LOWER COLORADO REGION | |
|--|----------------|
| RIVER CROSS SECTIONS | |
| DRAWN BY | SUBMITTED BY |
| TRACTED | RECOMMENDED |
| CHECKED | APPROVED |
| Boulder City, Nev. | Sept. 26, 1972 |
| | 423-300-997 |

FIGURE N

FIGURE 3

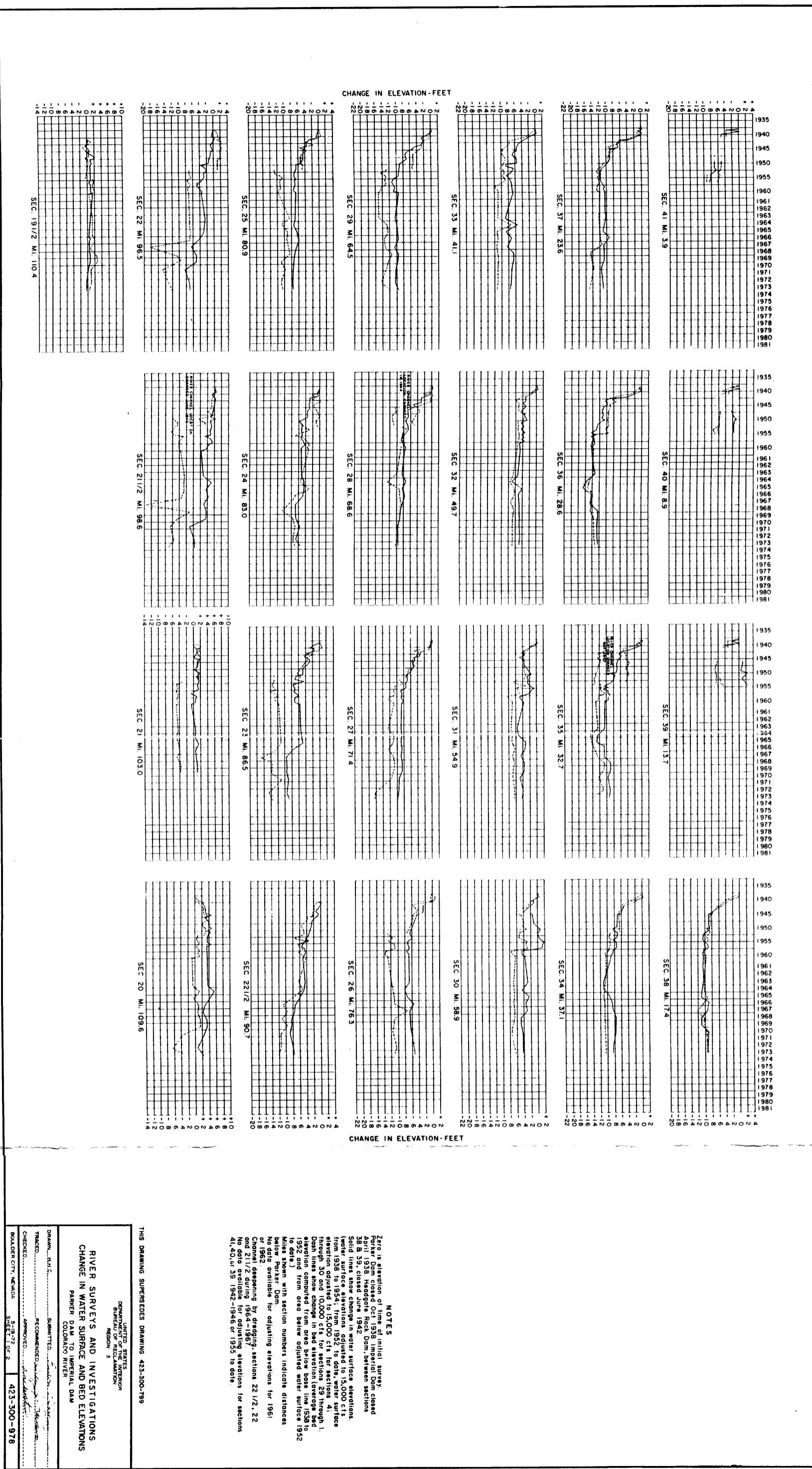


THIS DRAWING SUPERSEDES DRAWING 423-300-798

| | |
|--|------------------------------|
| RIVER SURVEYS AND INVESTIGATIONS | |
| CHANGE IN WATER SURFACE AND BED ELEVATIONS | |
| DAVIS DAM TO LAKE HAVASU | |
| COLORADO RIVER | |
| DRAWN... R.H.G. | SUBMITTED... J. L. T. |
| TRACED... | RECOMMENDED... J. L. T. |
| CHECKED... | APPROVED... J. L. T. |
| BOULDER CITY, NEVADA 5-1-72 | |

423-300-977

FIGURE 4

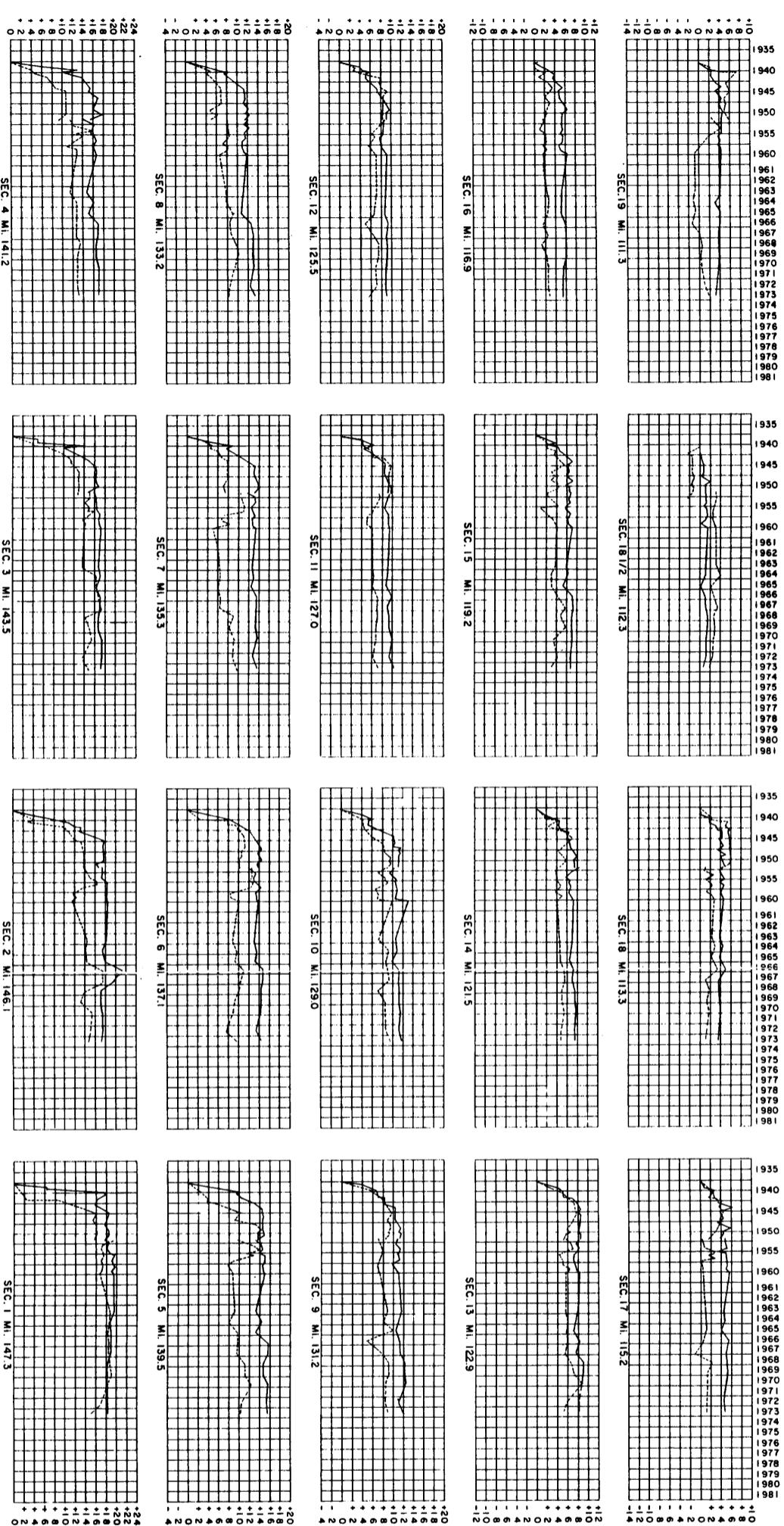


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FIGURE 4 (continued)



NOTES

Zero is elevation of lake at time of first survey.
Parker Dam closed Oct. 1938. Imperial Dam closed April 1939. Hedgegate Rock Dam between sections 38 & 39 closed in June of 1942.
Solid lines show change in water surface elevation (water level) versus time adjusted to 15,000 c.f.s. From 1938 to 1952. From 1952 to present water surface elevation adjusted to 10,000 c.f.s.
Dashed lines show change in water bed elevation (computed from area below base line 1938 to 1952 and from area below adjusted water surface 1952 to date).
Miles shown with section numbers indicate distances below Parker Dam.

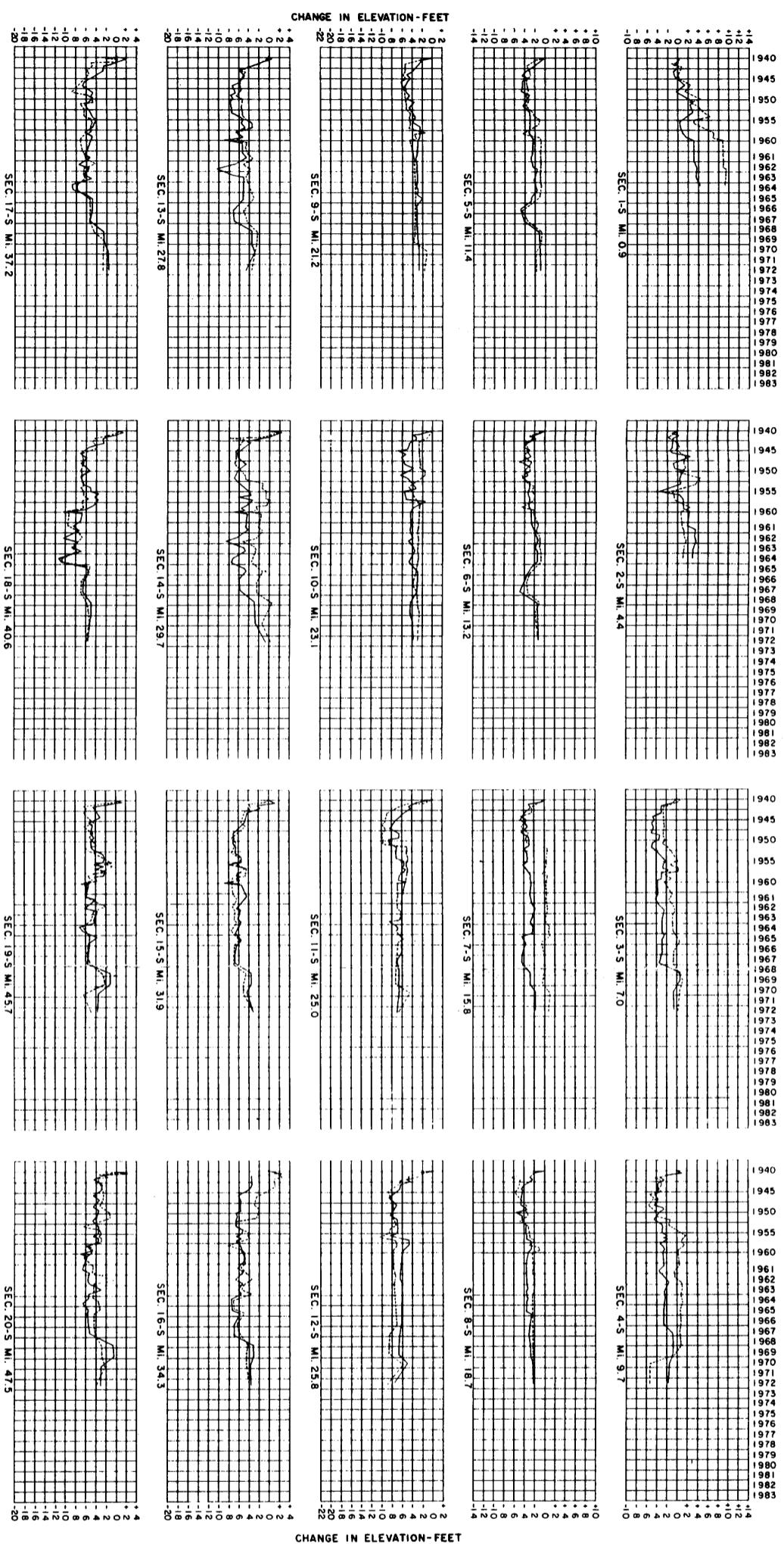
THIS DRAWING SUPERSEDES DRAWING 423-300-800

DEPARTMENT OF THE UNITED STATES
BUREAU OF RECLAMATION
REVISION 3

RIVER SURVEYS AND INVESTIGATIONS
CHANGE IN WATER SURFACE AND BED ELEVATIONS
PARKER DAM TO IMPERIAL DAM
COLORADO RIVER

| | |
|-------------------------------|-----------------------------------|
| DRAWN, H.H.C. | SUBMITTED, <i>J. L. Johnson</i> |
| TRIMMED, <i>J. L. Johnson</i> | RECOMMENDED, <i>J. L. Johnson</i> |
| CHECKED, <i>J. L. Johnson</i> | APPROVED, <i>J. L. Johnson</i> |
| BOULDER CITY, NEVADA | |
| SHEET 2 OF 2 | |
| 423-300-979 | |

FIGURE 5



NOTES

Zero is elevation at time of initial survey (1940)

Change is plotted as change in elevation rather than elevation above datum.

Datum is projected to river bottom elevation (adjusted to discharge of 5,000 c.f.s.)

Solid lines show change in water surface elevation (adjusted to discharge of 5,000 c.f.s.)

Dashed lines show changes in bed elevation (computed from area below adjusted water surface.)

Miles shown with section numbers are distances below Imperial Dam.

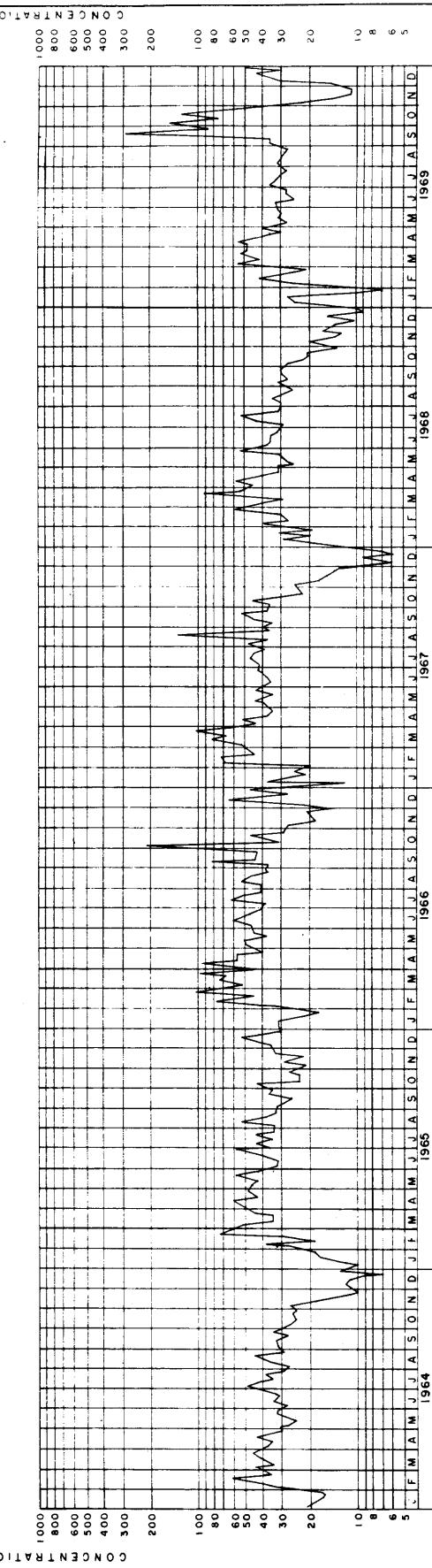
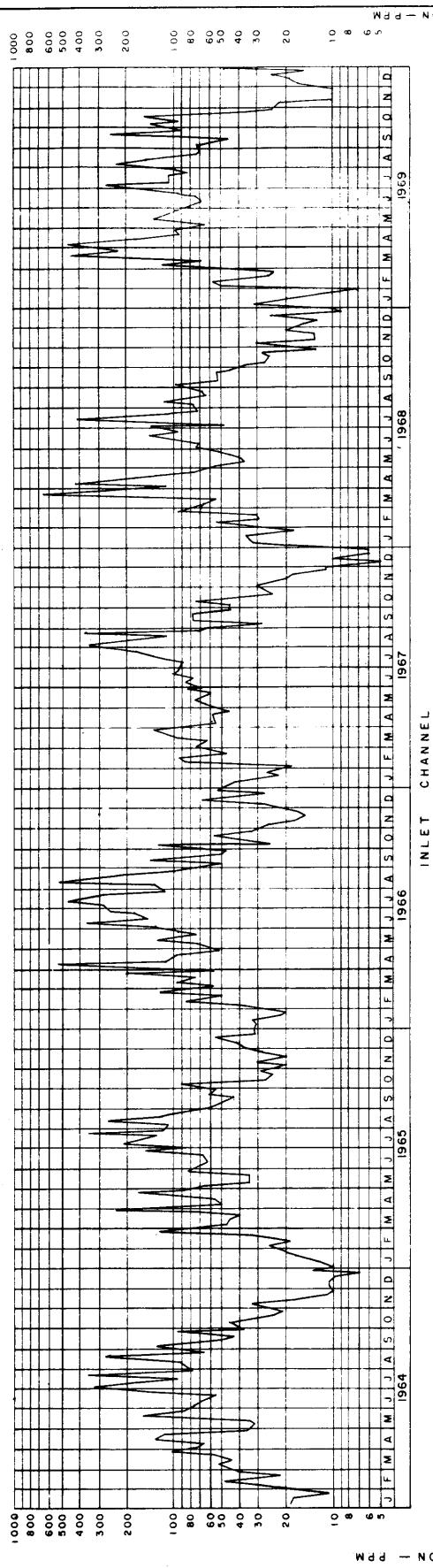
No survey made of sections 1-S or 2-S after 1964.

Dredging was performed between Laguna Dam and 6-S in 1969. Soil was deposited within

the channel and, therefore, dredging is not reflected in the above sections.

| | |
|---|---|
| THIS DRAWING SUPERSEDES DRAWING 423-300-801 | |
| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 | |
| RIVER SURVEYS AND INVESTIGATIONS | |
| CHANGE IN WATER SURFACE AND BED ELEVATIONS | |
| IMPERIAL DAM TO INTERNATIONAL BOUNDARY COLORADO RIVER | |
| DRAWN..... H.A.C. SUBMITTED..... L. Shaeffer | RECOMMENDED..... J. G. Kunkle |
| TRACED..... D.R.B. APPROVED..... R. A. Johnson | CHEKED..... APPROVED..... R. A. Johnson |
| Boulder City, Nevada | 423-300-980 |

FIGURE 6



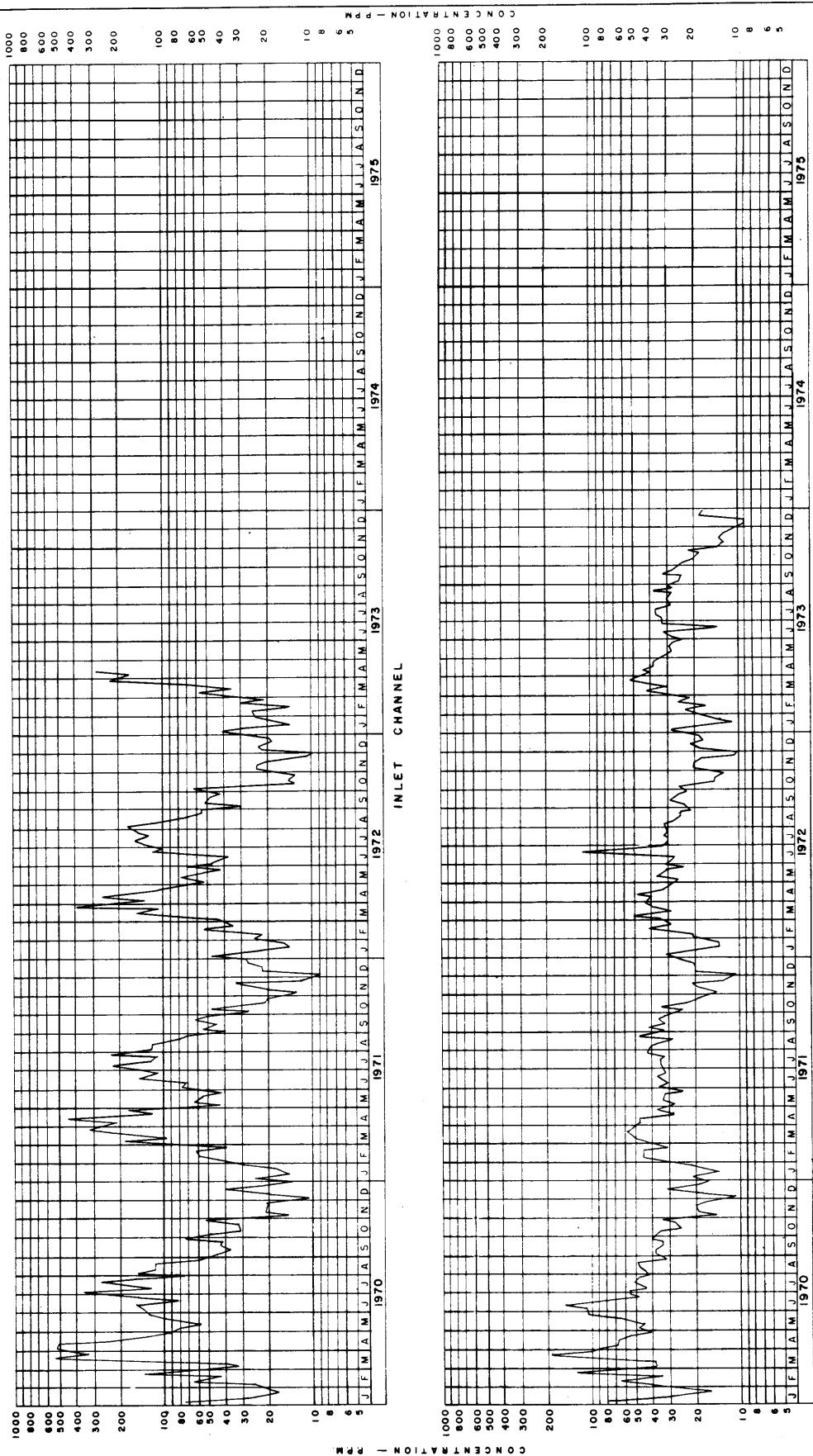
STATION 60

NOTES

Data furnished by Imperial Irrigation District

| |
|---|
| DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 SUSPENDED LOAD ALL-AMERICAN CANAL |
| DRAWN.....SUBMITTED..... <i>J. H. C.</i> |
| TRACED.....RECOMMENDED..... <i>J. H. C.</i> |
| CHECKED.....APPROVED..... <i>J. H. C.</i> |
| 400 ft ² |
| 6725.00 dated 1968 & 1969 |
| Boulder City, Nevada 1-9-1969 |
| 423-300 771 |

FIGURE 6 (continued)

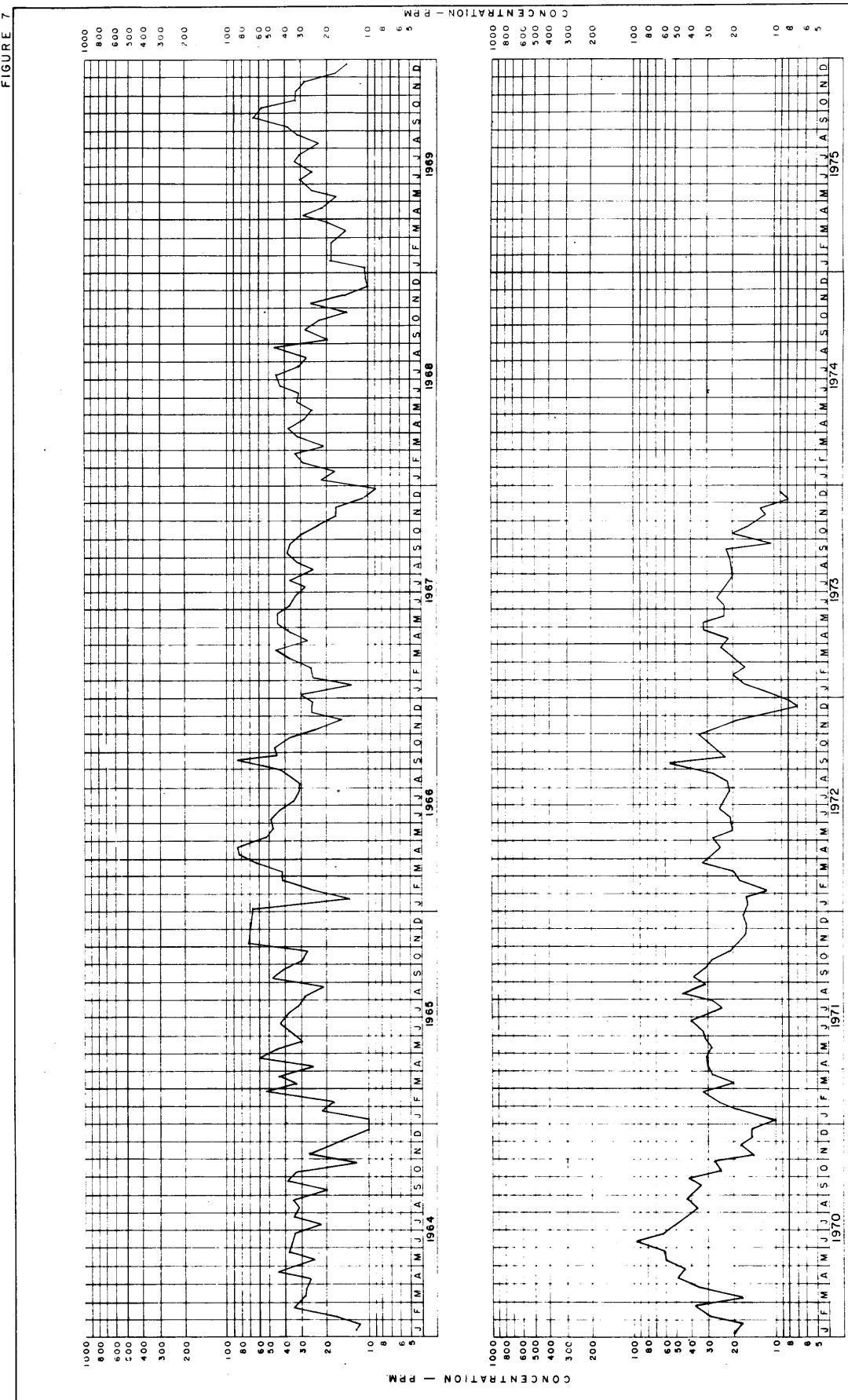


NOTES

Data furnished by Imperial Irrigation District
Sediment sampling in the Inlet Channel discontinued
in April 1973.

| | | | |
|--|------------------|-----------------|---------------|
| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION ALL AMERICAN CANAL REGION 3 | | | |
| RIVER SURVEYS AND INVESTIGATIONS | | | |
| SUSPENDED LOAD | | | |
| ALL AMERICAN CANAL | | | |
| DRAWN..... | NHC..... | SUBMITTED..... | APPROVED..... |
| TRACED..... | RECOMMENDED..... | SUPERVISOR..... | BRANCH..... |
| CHECKED..... | INITIAL..... | REVIEWED..... | RECORDED..... |

FIGURE 7



NOTES

GILA GRAVITY MAIN CANAL
STATION 144 + 50

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| UNITED STATES DEPARTMENT OF THE INTERIOR |
| BUREAU OF RECLAMATION |
| REGION 3 |
| RIVER SURVEYS AND INVESTIGATIONS |
| GILA GRAVITY MAIN CANAL |
| DRAWN... BY..... |
| SUSPENDED LOAD |
| TRACED..... |
| RECOMMENDED..... |
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| APPROVED..... |
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| 1000-300-772 |
| WATER CITY, NEVADA |

FIGURE 8

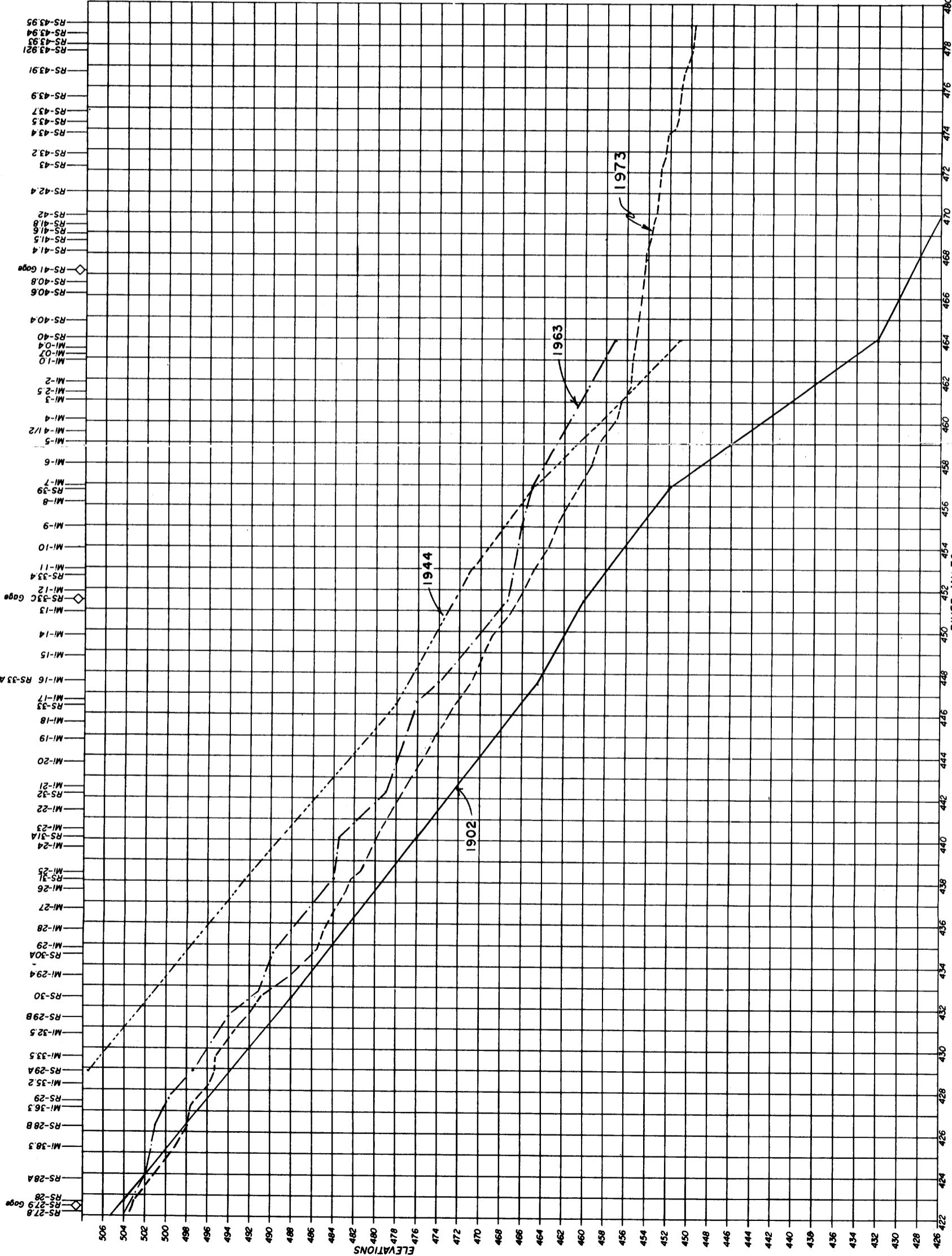


FIGURE 9

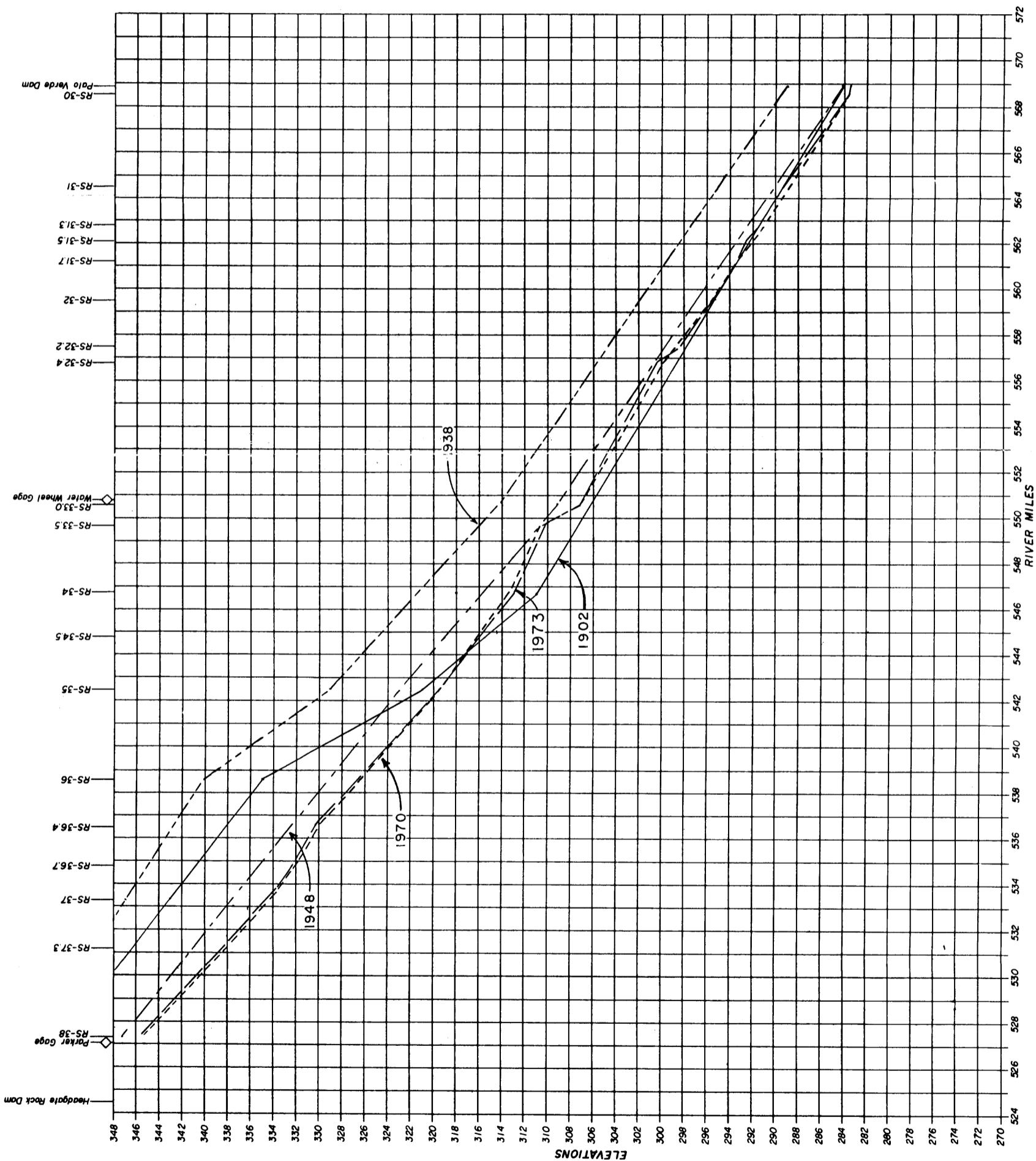


FIGURE 10

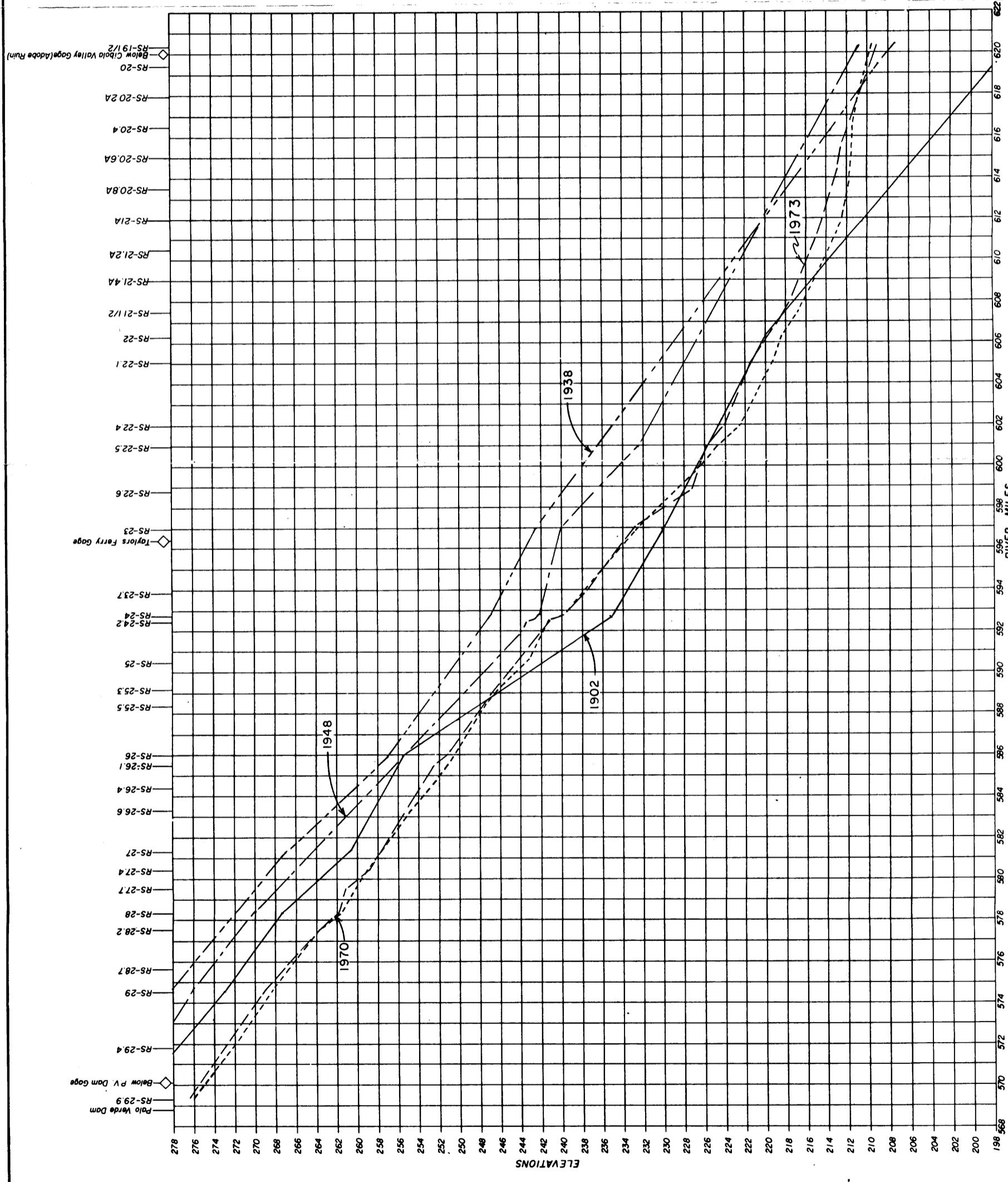


FIGURE II

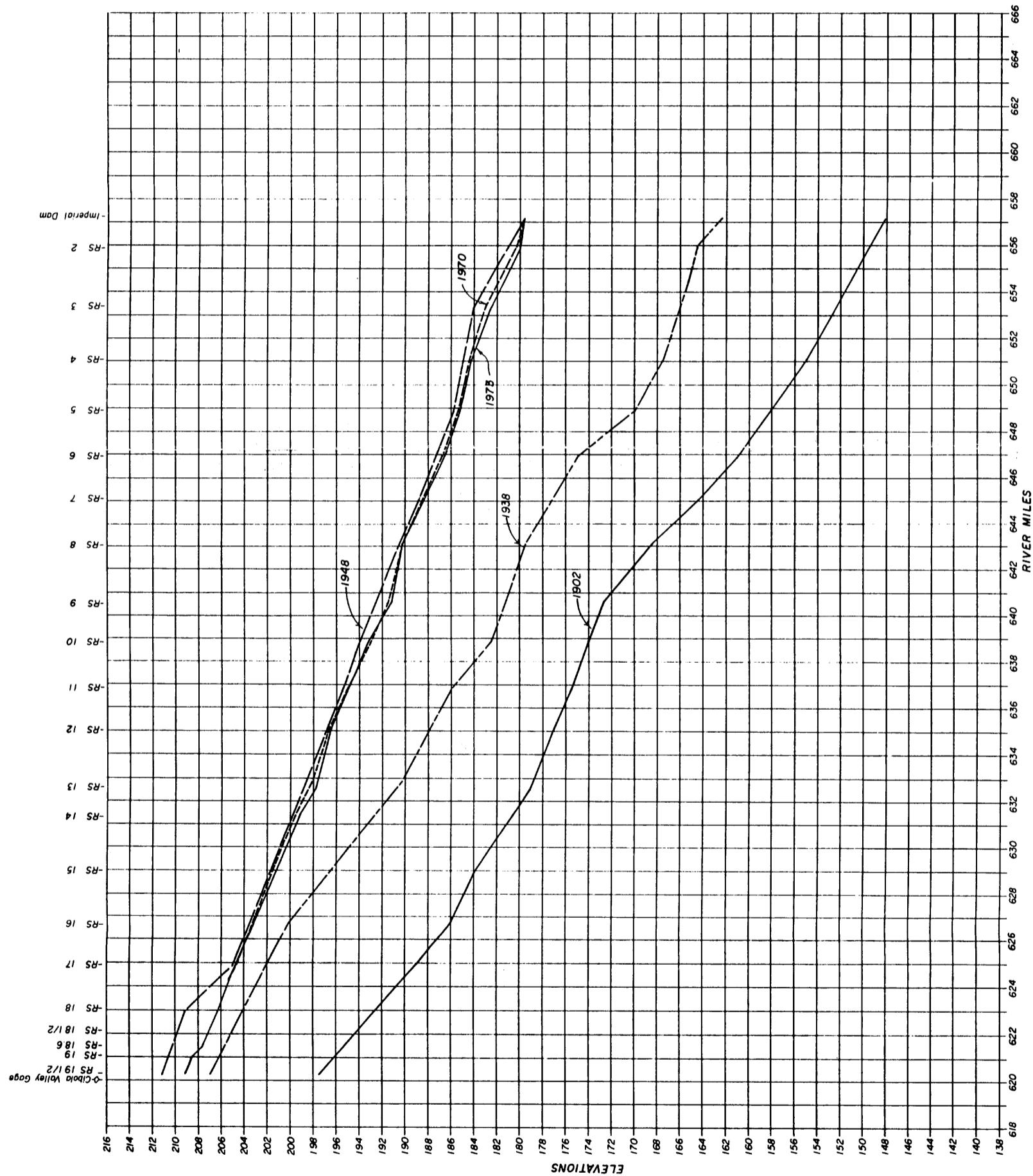
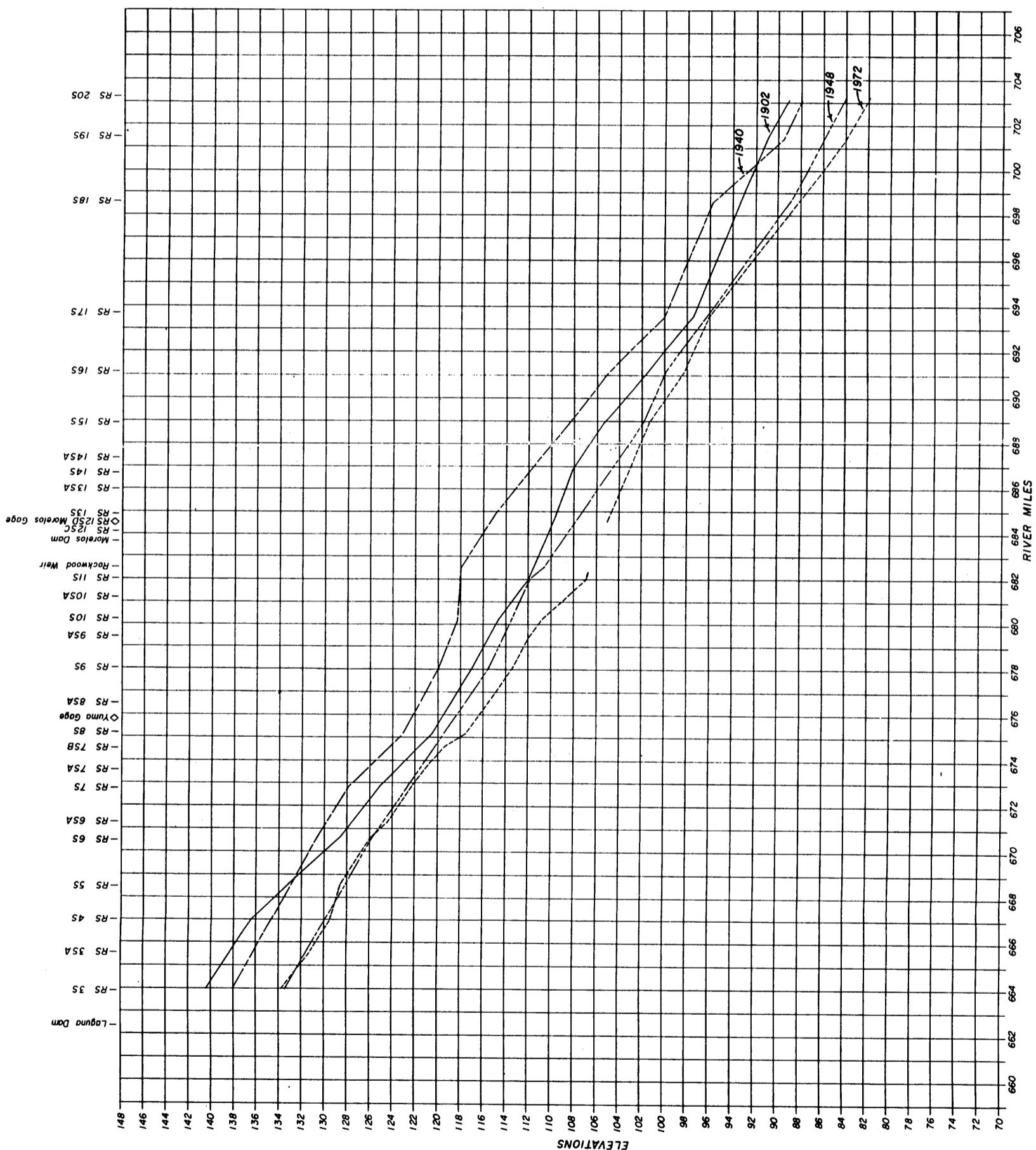
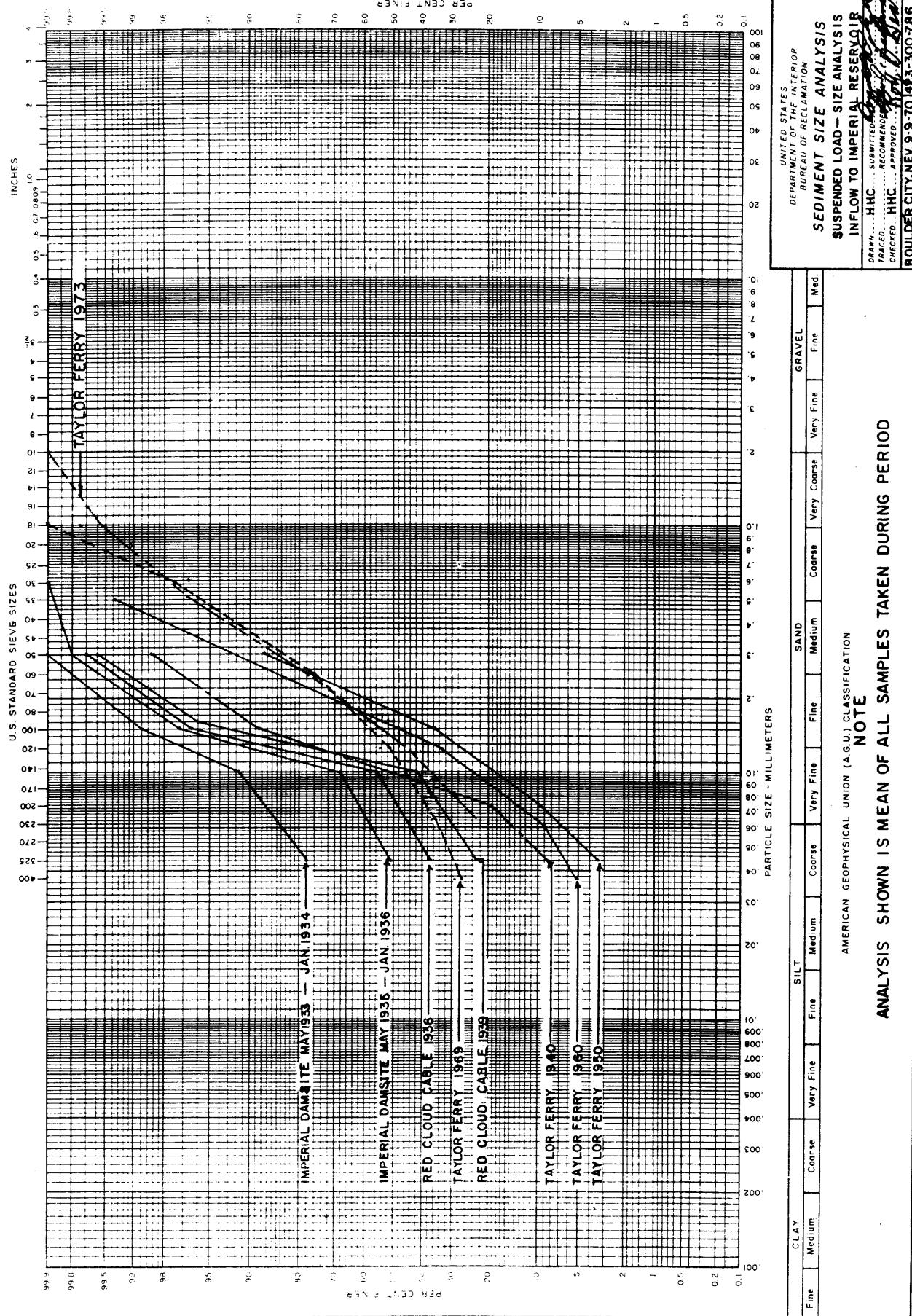


FIGURE 12

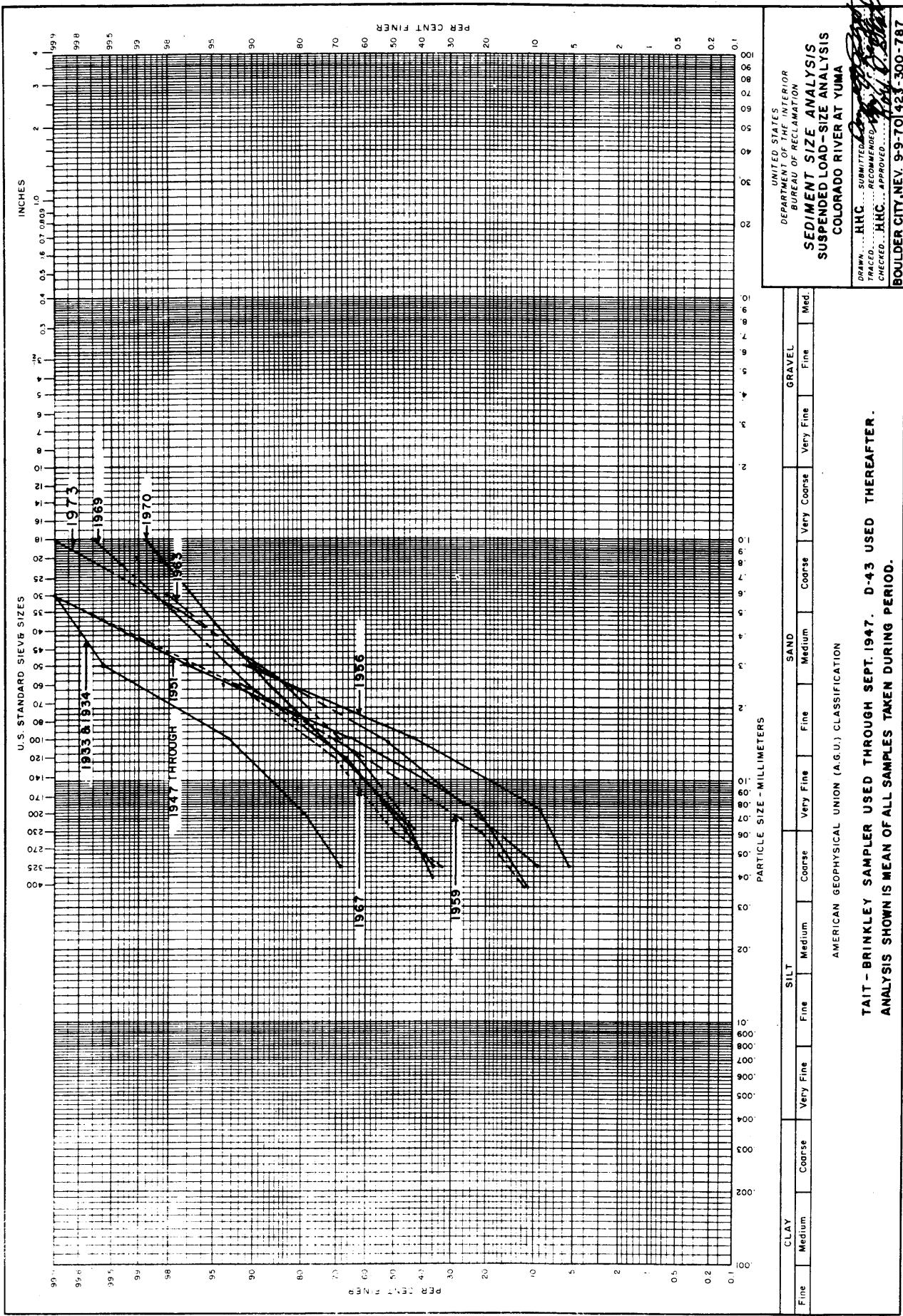


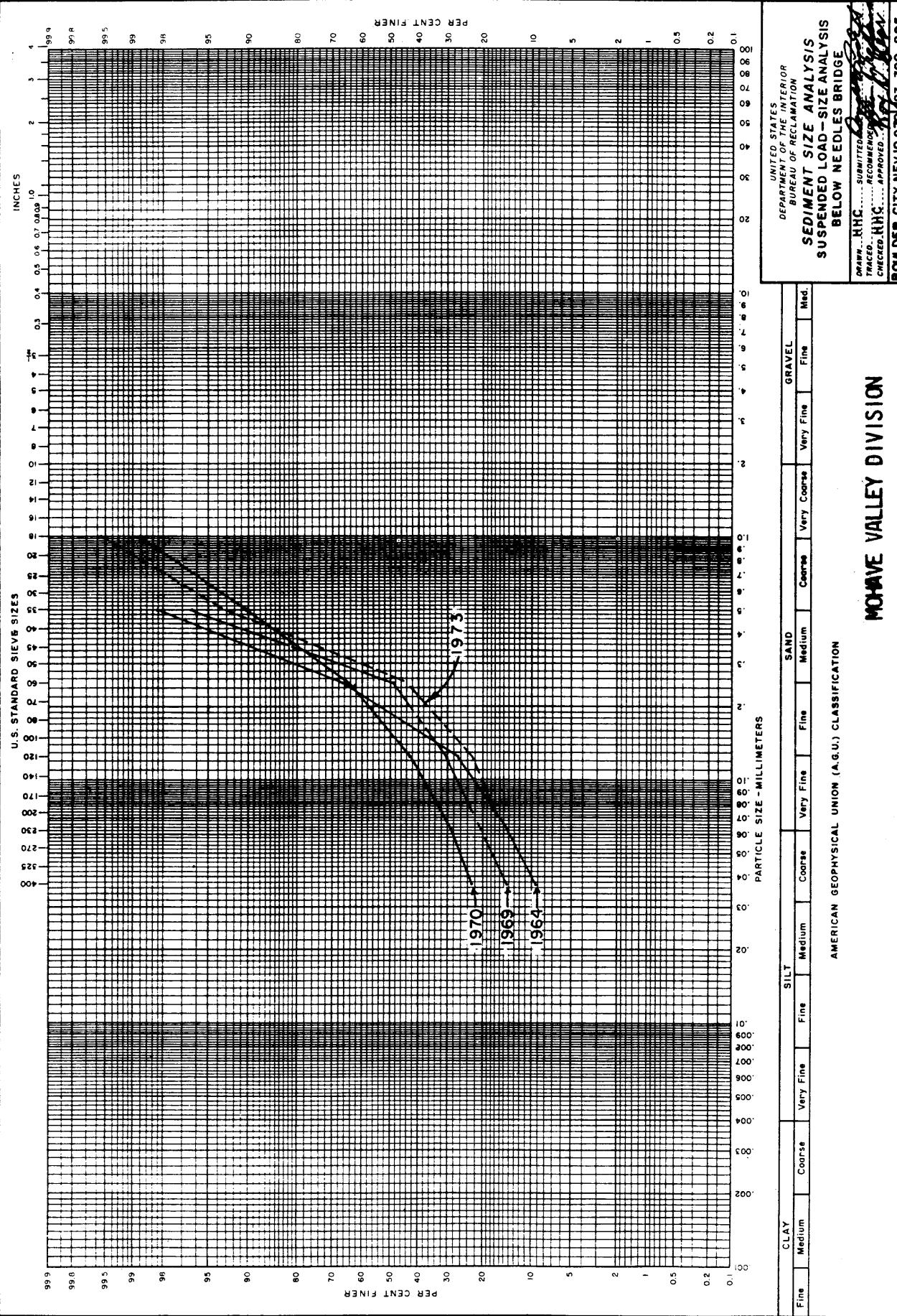
| | | | |
|--|-----------------|----------------|-----------------|
| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION LOWER COLORADO RIVER FRONT WORK & LEVEE SYSTEM | | | |
| LAGUNA DAM TO INTERNATIONAL BOUNDARY WATER SURFACE PROFILES | | | |
| DRAWN BY | SUBMITTED BY | RECOMMENDED BY | APPROVED BY |
| HNC | John J. Johnson | J. H. Jones | John C. Blanton |
| TRACED | | | |
| CHECKED | | | |
| RECALLED | | | |
| BOULDER CITY, NEVADA | | 10-30-72 | 423-300-1004 |

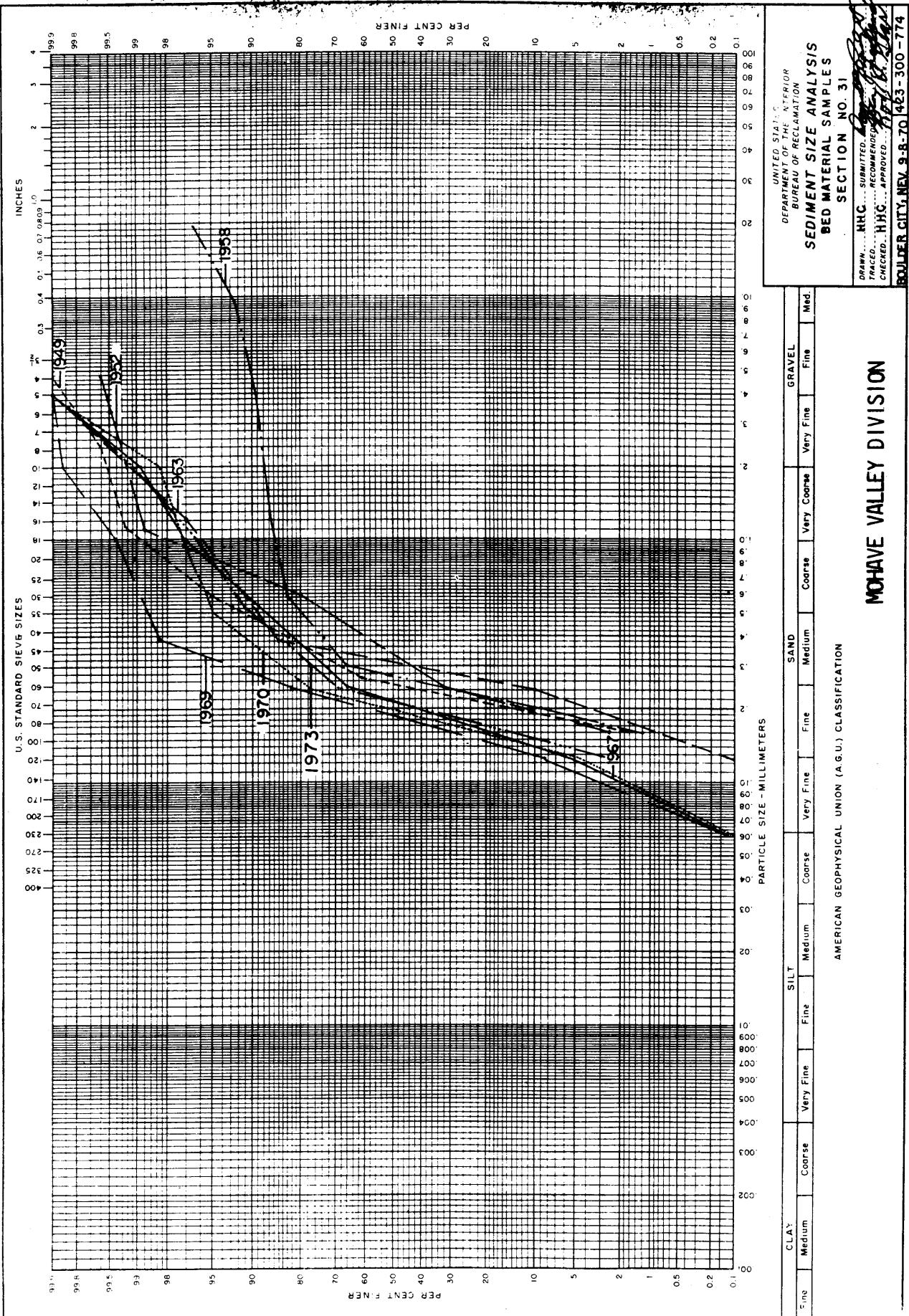


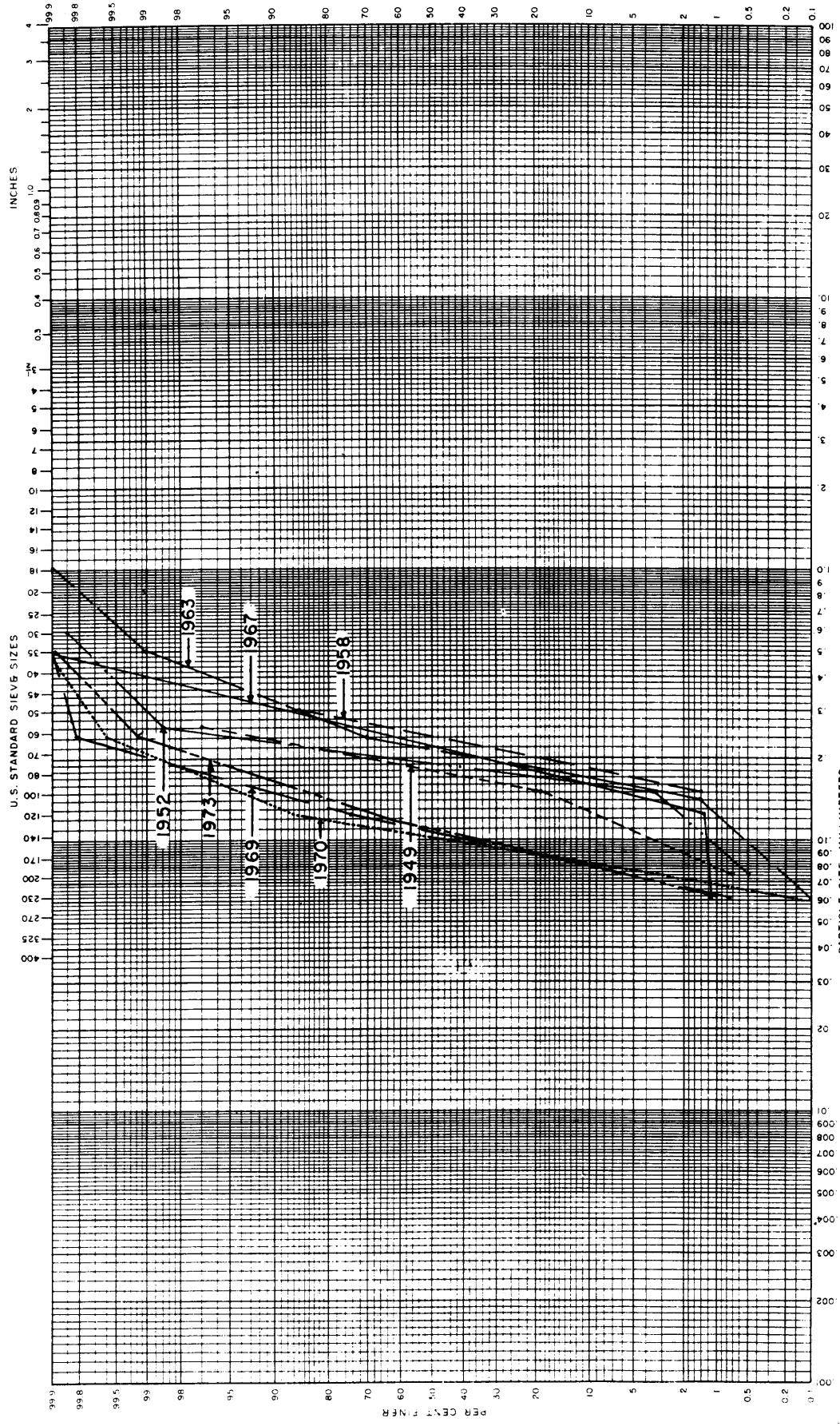
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SEDIMENT SIZE ANALYSIS
SUSPENDED LOAD - SIZE ANALYSIS
INFLOW TO IMPERIAL RESERVOIR
DRAFT HHC SUBMITTED
RECOMMENDED APPROVED
CHECKED APPROVED
BOULDER CITY, NEV 9-9-70 (43-300-786)

GPO 854681.
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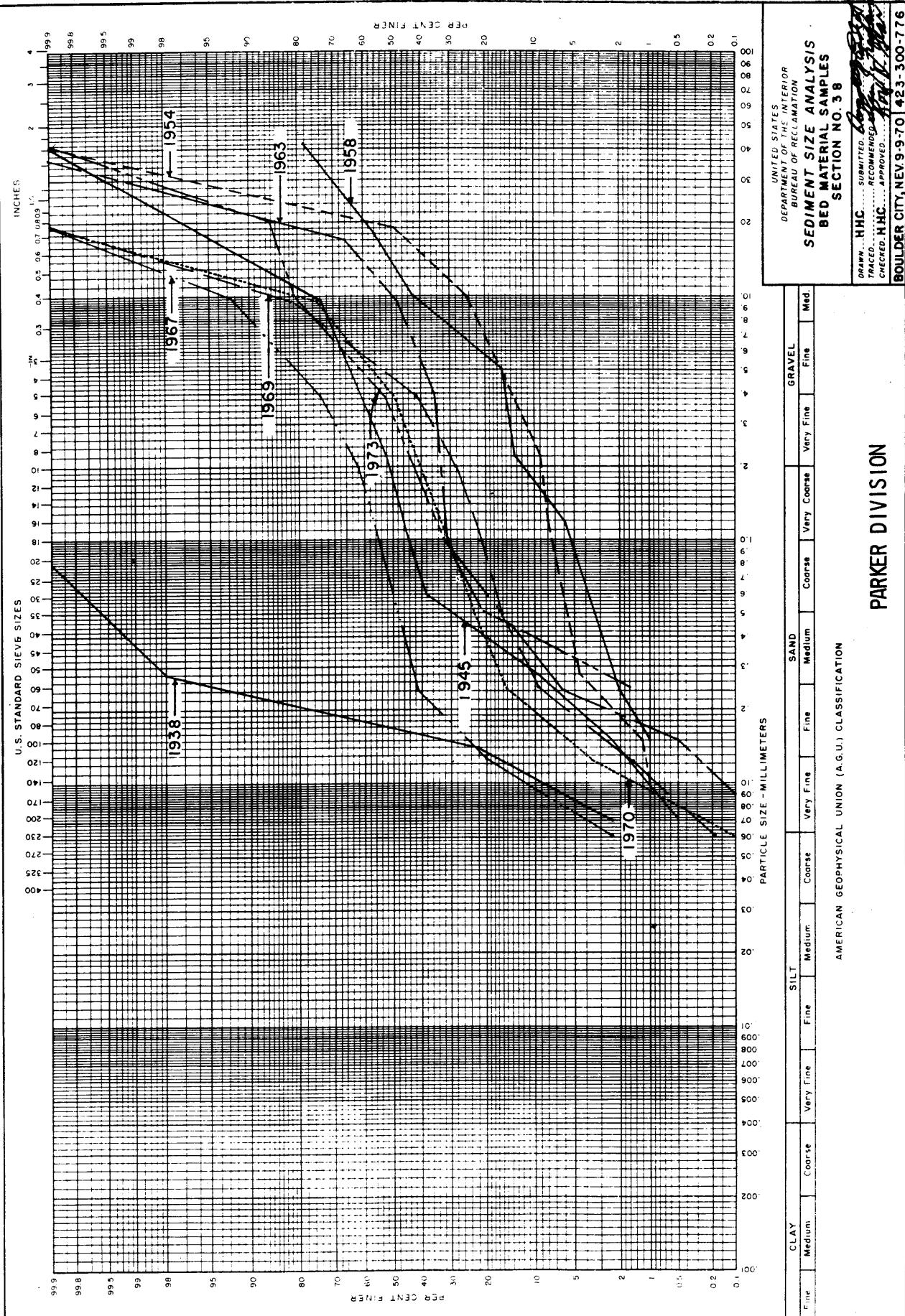


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SEDIMENT SIZE ANALYSIS
BED MATERIAL SAMPLES
SECTION NO. 43

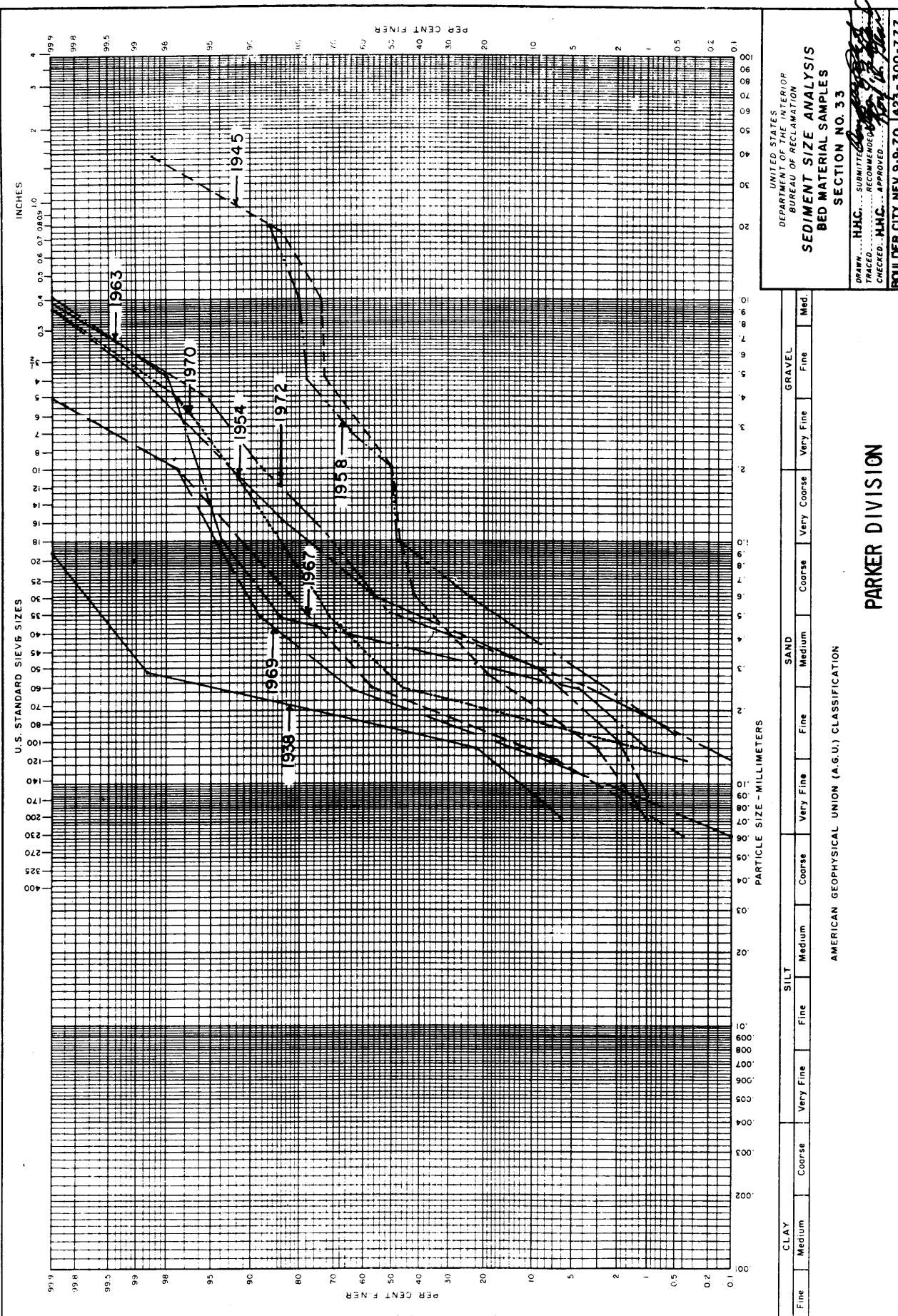
DRAWN HHG SUBMITTED HHG
TRACED HHG RECOMMENDED HHG
CHECKED HHG APPROVED HHG

BOULDER CITY, NEV 9-9-70 423-300-775

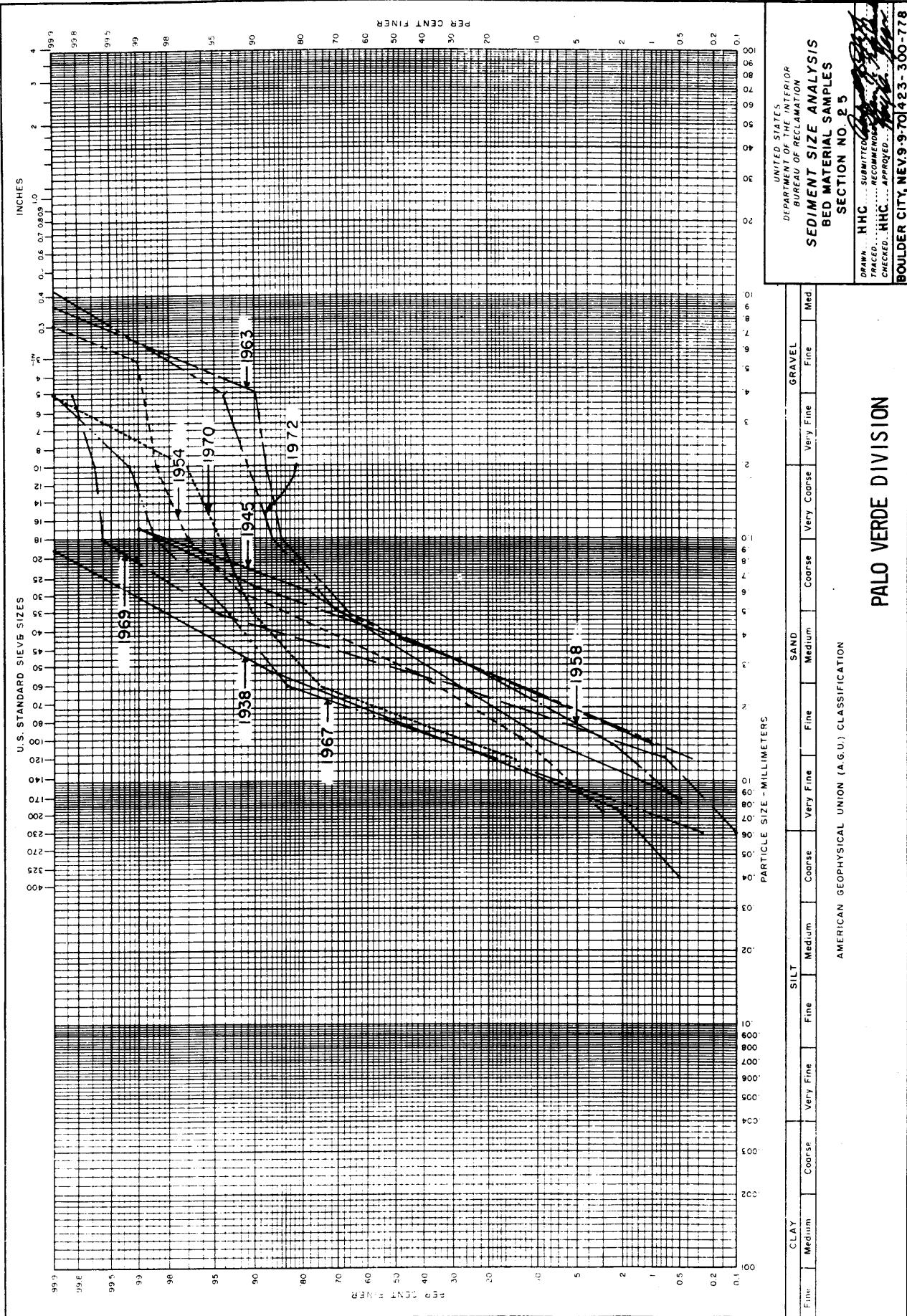
TOPOCK GORGE DIVISION



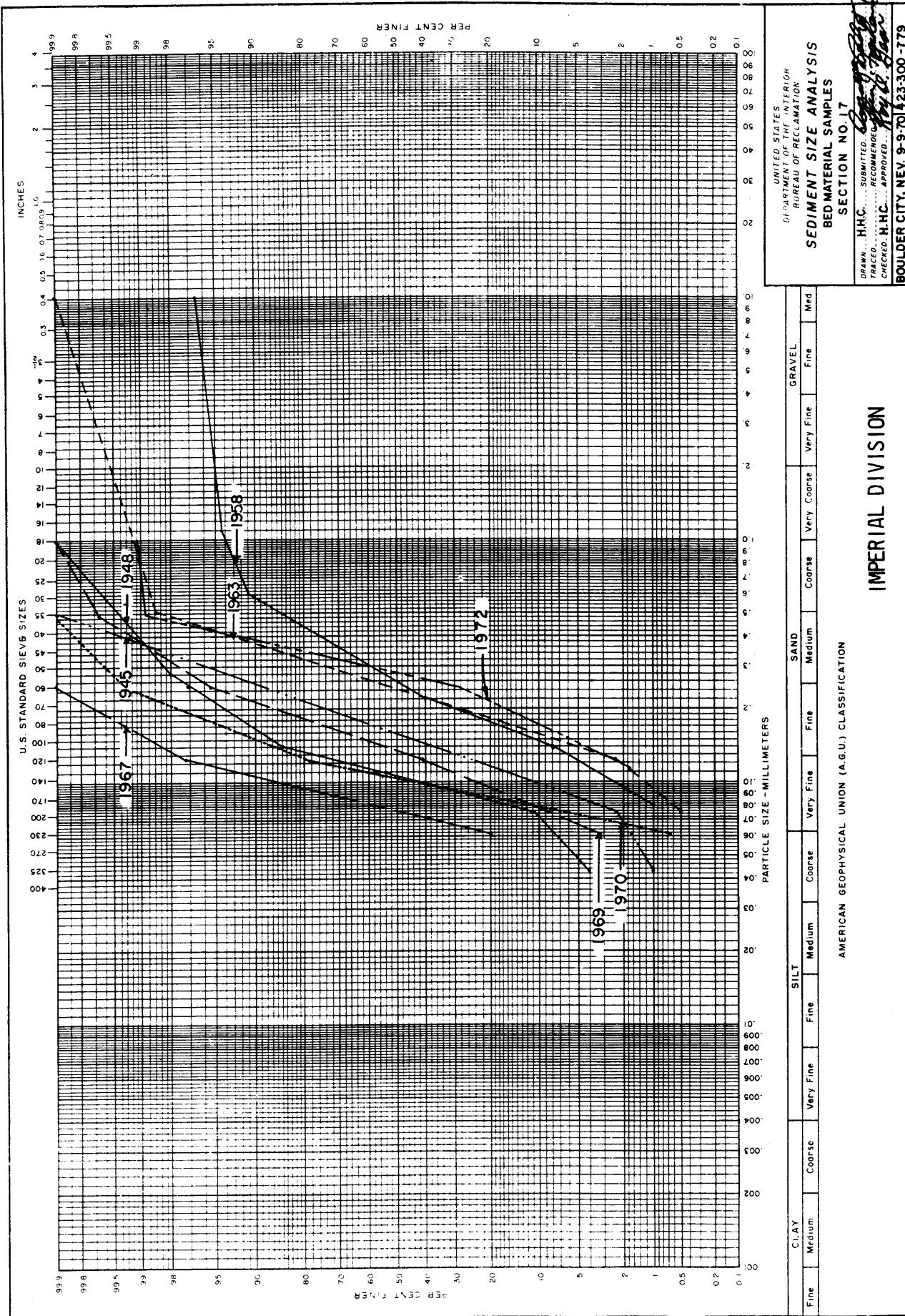
PARKER DIVISION



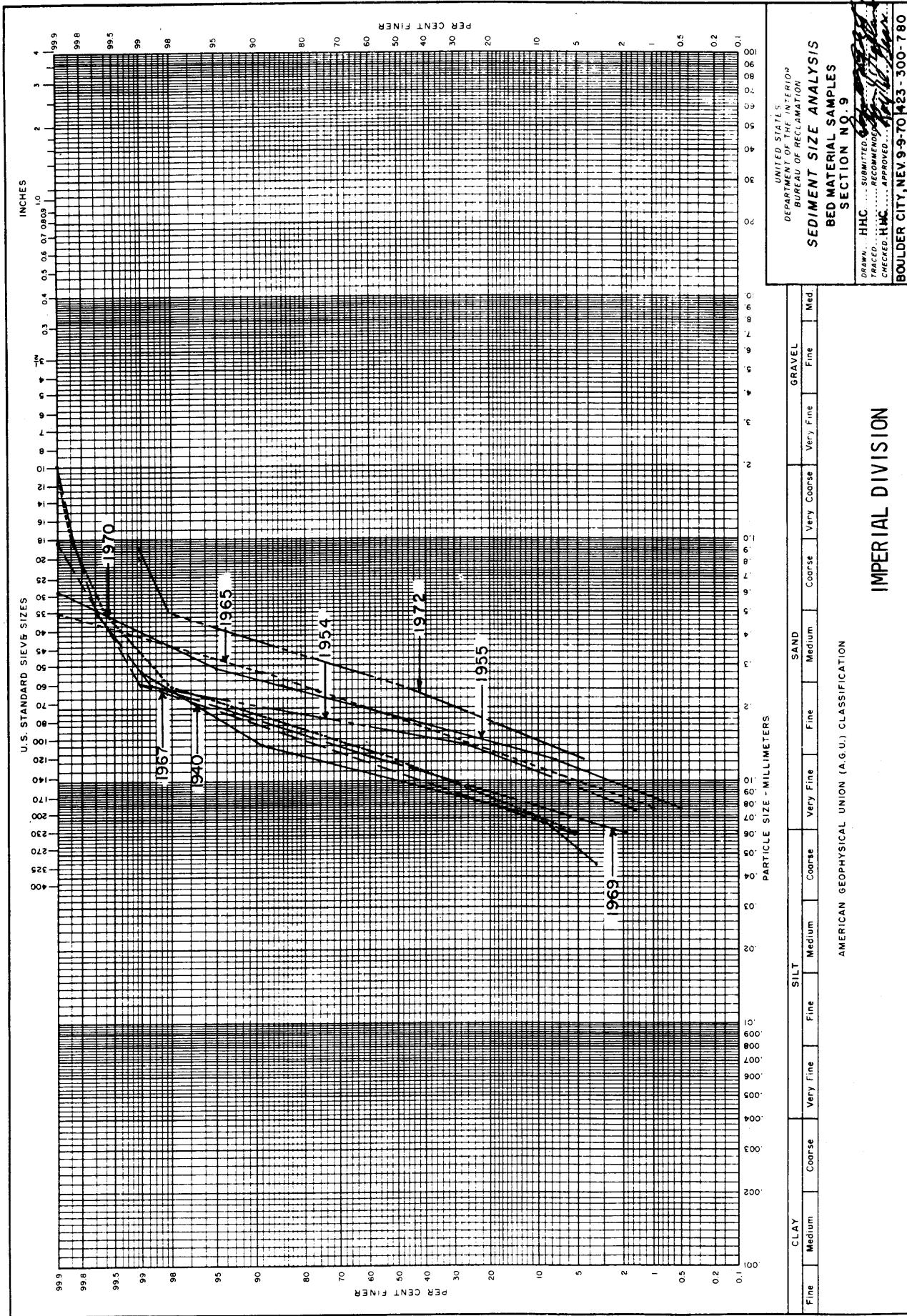
GPO 854681
G - 7

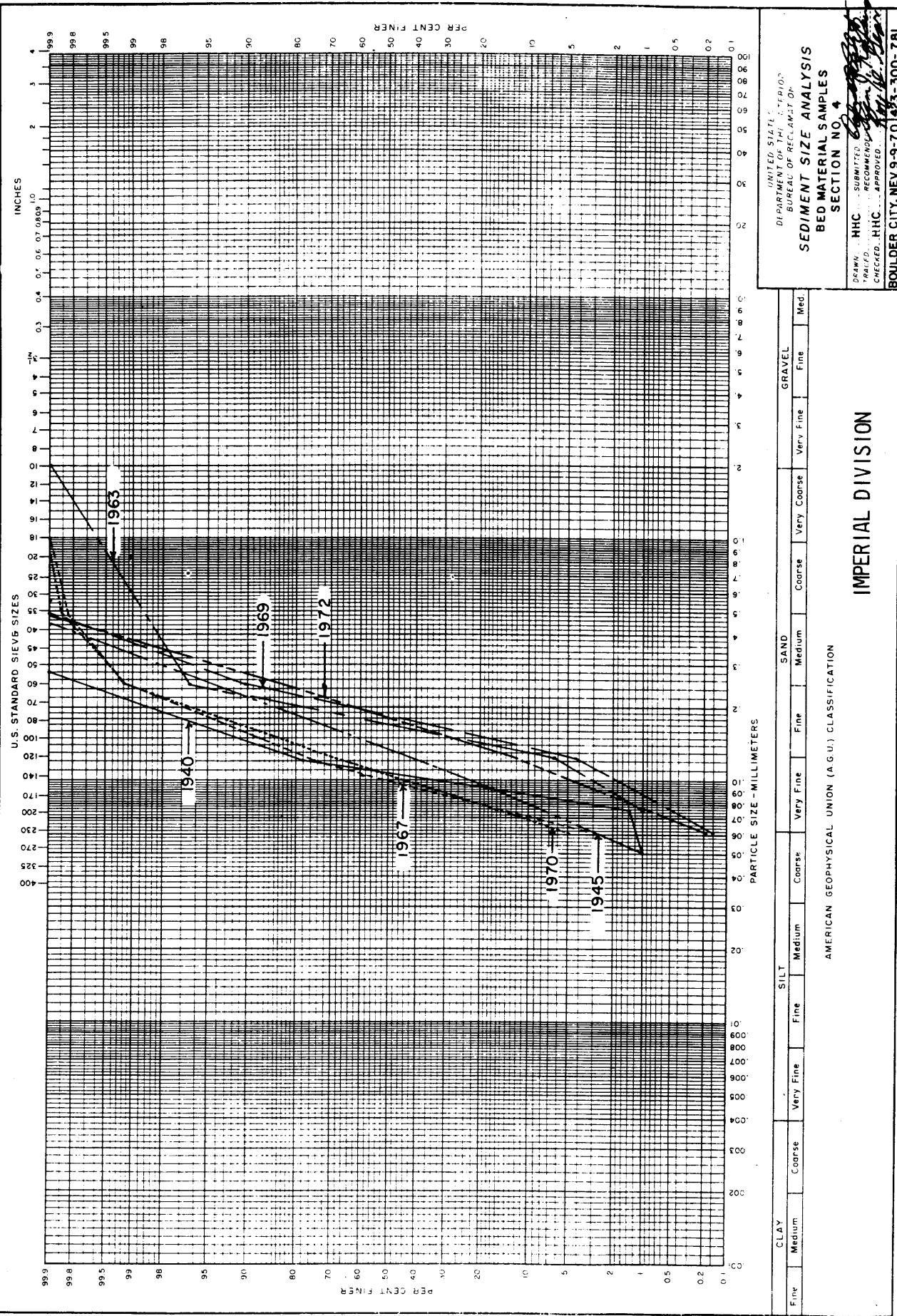


GPO 854681
20 G - 7



IMPERIAL DIVISION





(3-62)
G - 24

**UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION**

**SEDIMENT SIZE ANALYSIS
BED SAMPLE MATERIAL
SECTION 7-S**

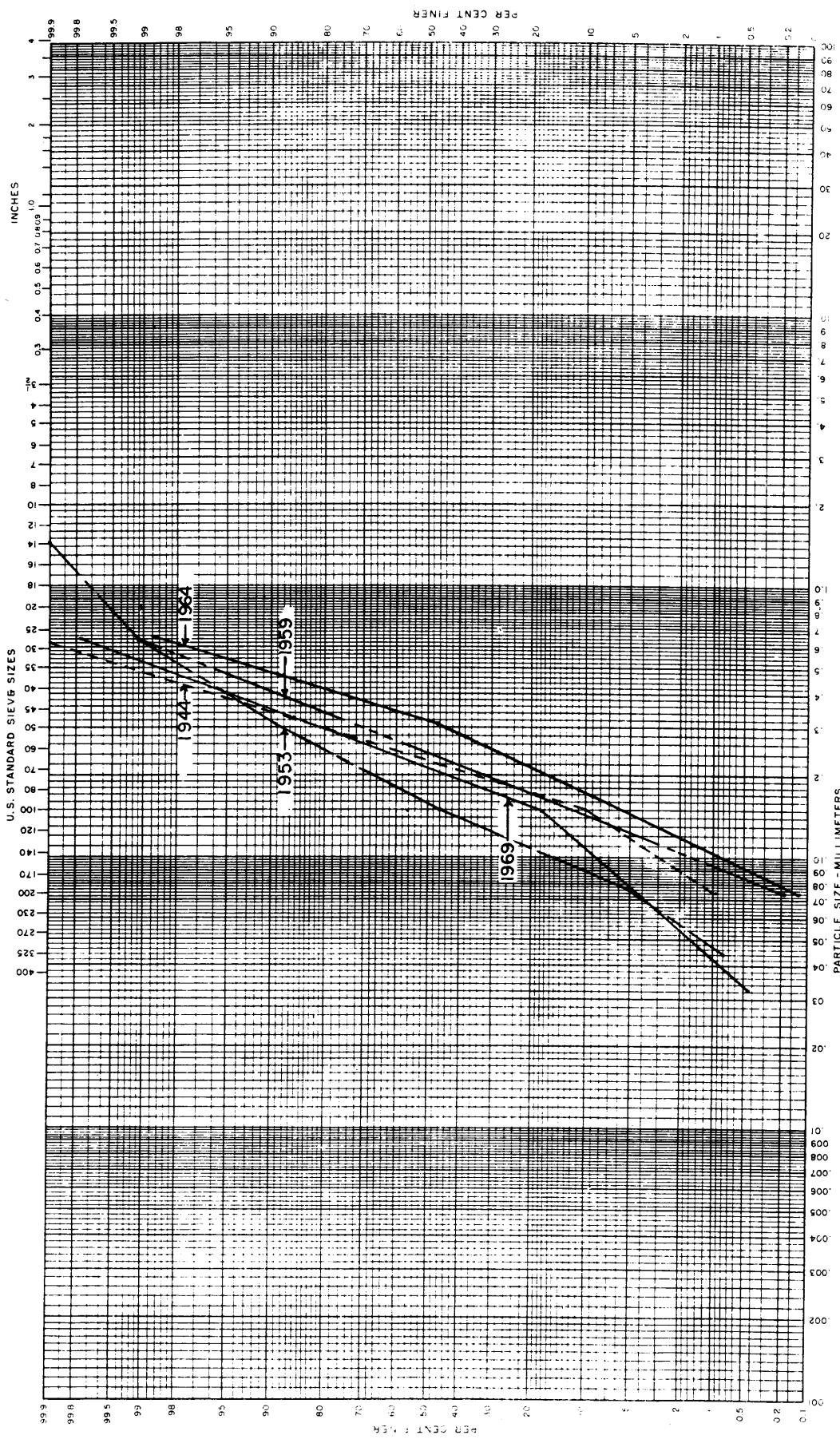
YUMA DIVISION

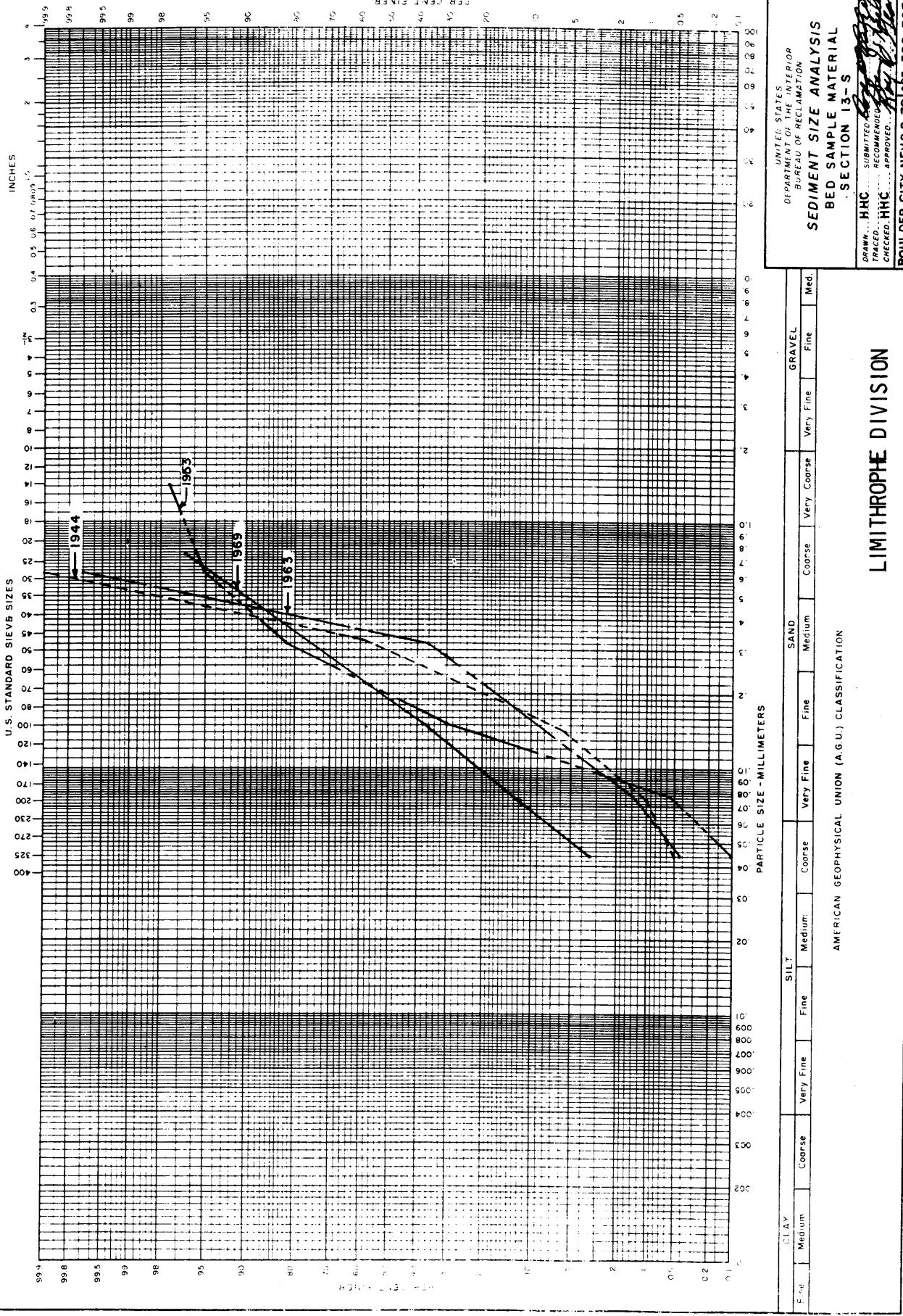
AMERICAN GEOPHYSICAL UNION (A.G.U.) CLASSIFICATION

CLAY

| Fine | Medium | Coarse | Very Fine | Fine | SILT | Medium | Fine | Very Coarse | Coarse | Medium | Fine | Fine | Med |
|------|--------|--------|-----------|------|------|--------|------|-------------|--------|--------|------|------|-----|
|------|--------|--------|-----------|------|------|--------|------|-------------|--------|--------|------|------|-----|

**GPO 854681
423-300-782**





UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
~~RECOMMENDED~~
SEDIMENT SIZE ANALYSIS
BED MATERIAL SAMPLES
SECTION 20-S
DRAWN... HHC... SUBMITTED...
TRACED... RECOMMENDED...
CHECKED... APPROVED...
BOULDER CITY, NEV 99704 423-350-784

LIMITROPH DIVISION

| CLAY | FINE | SILT | | | GRAVEL | | | MED. |
|------|------|--------|--------|------|-----------|--------|--------|------|
| | | MEDIUM | COARSE | FINE | VERY FINE | COARSE | MEDIUM | |
| | | | | | | | | |

AMERICAN GEOPHYSICAL UNION (A.G.U.) CLASSIFICATION

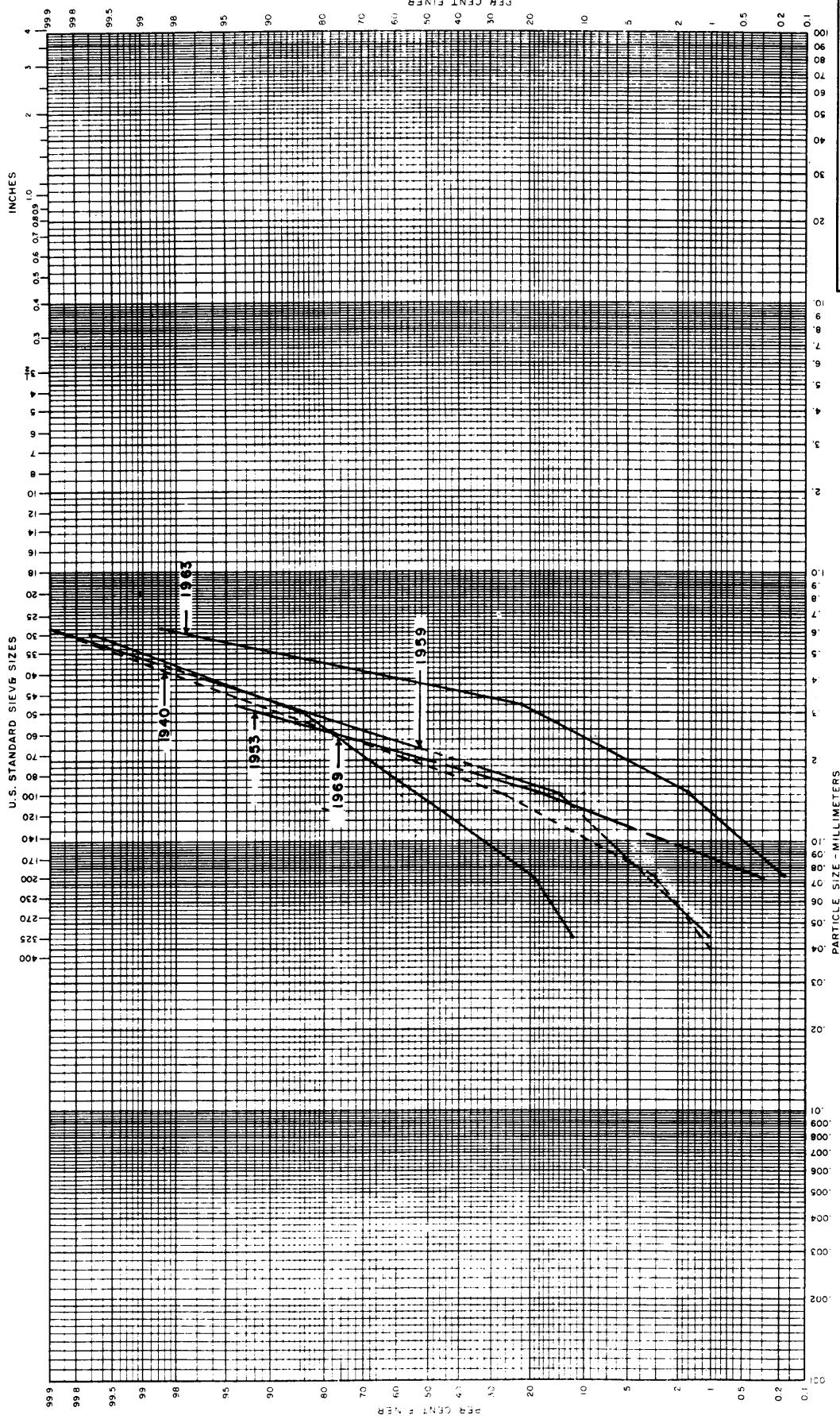


FIGURE 27

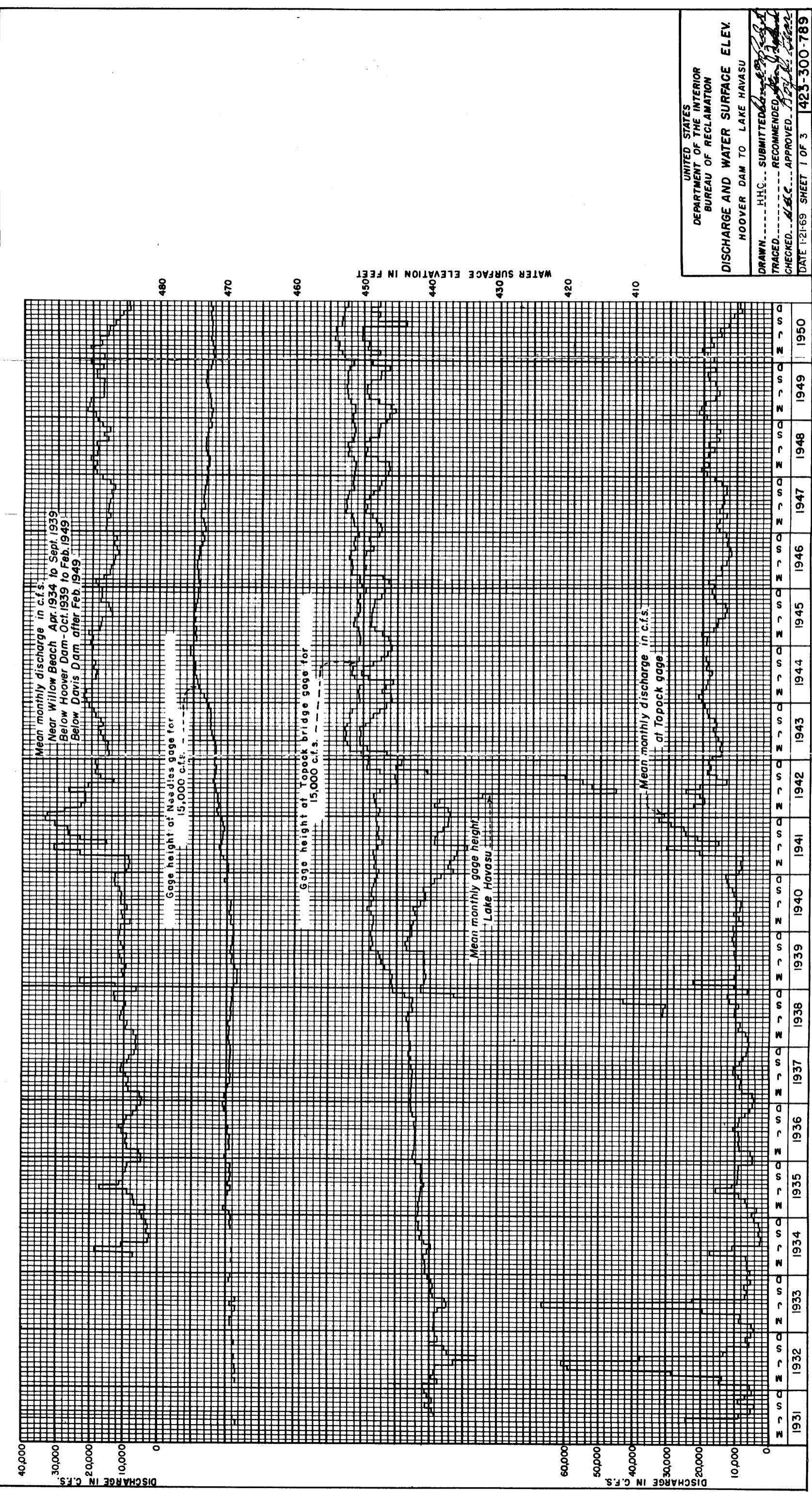


FIGURE 27 (continued)

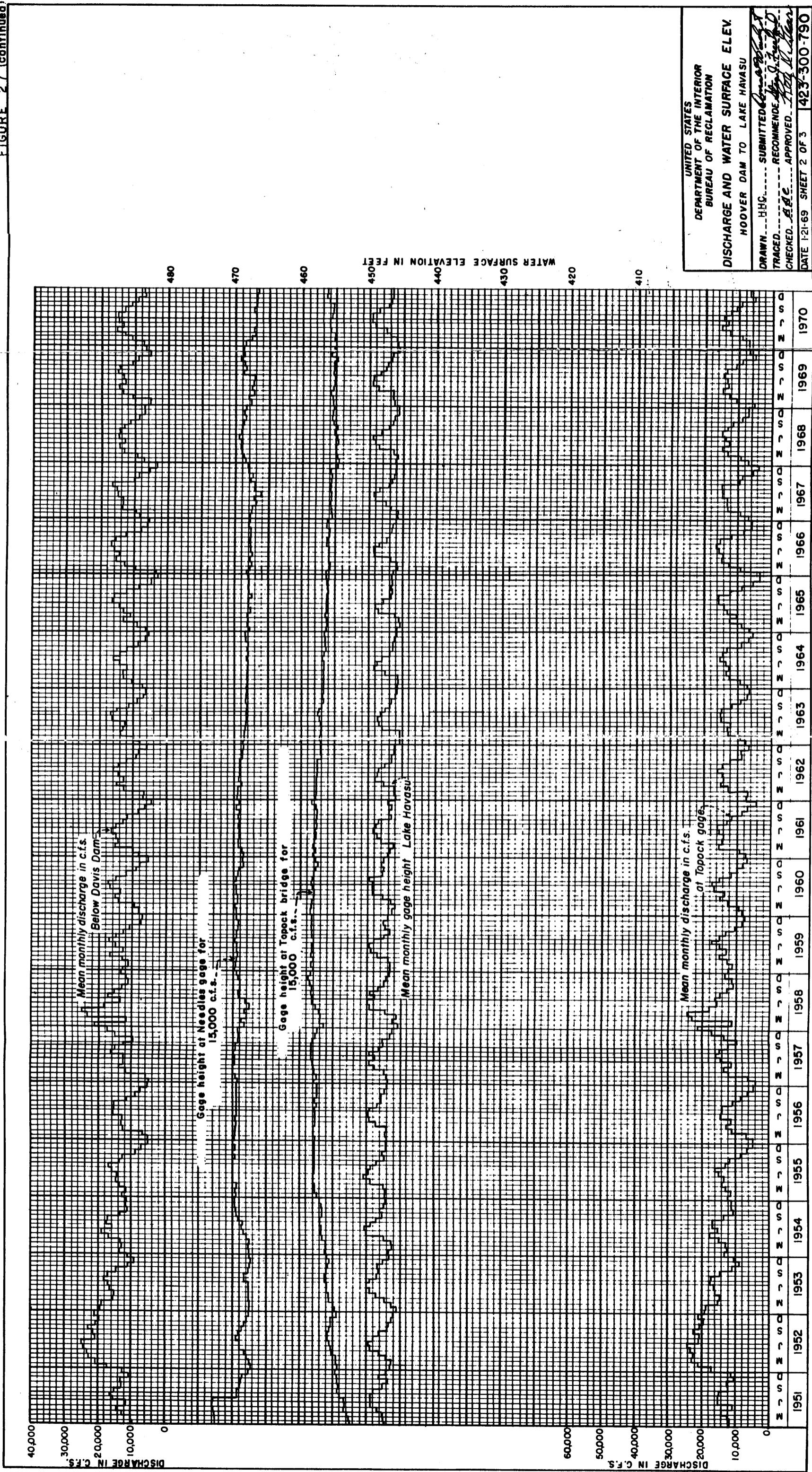


FIGURE 27 (continued)

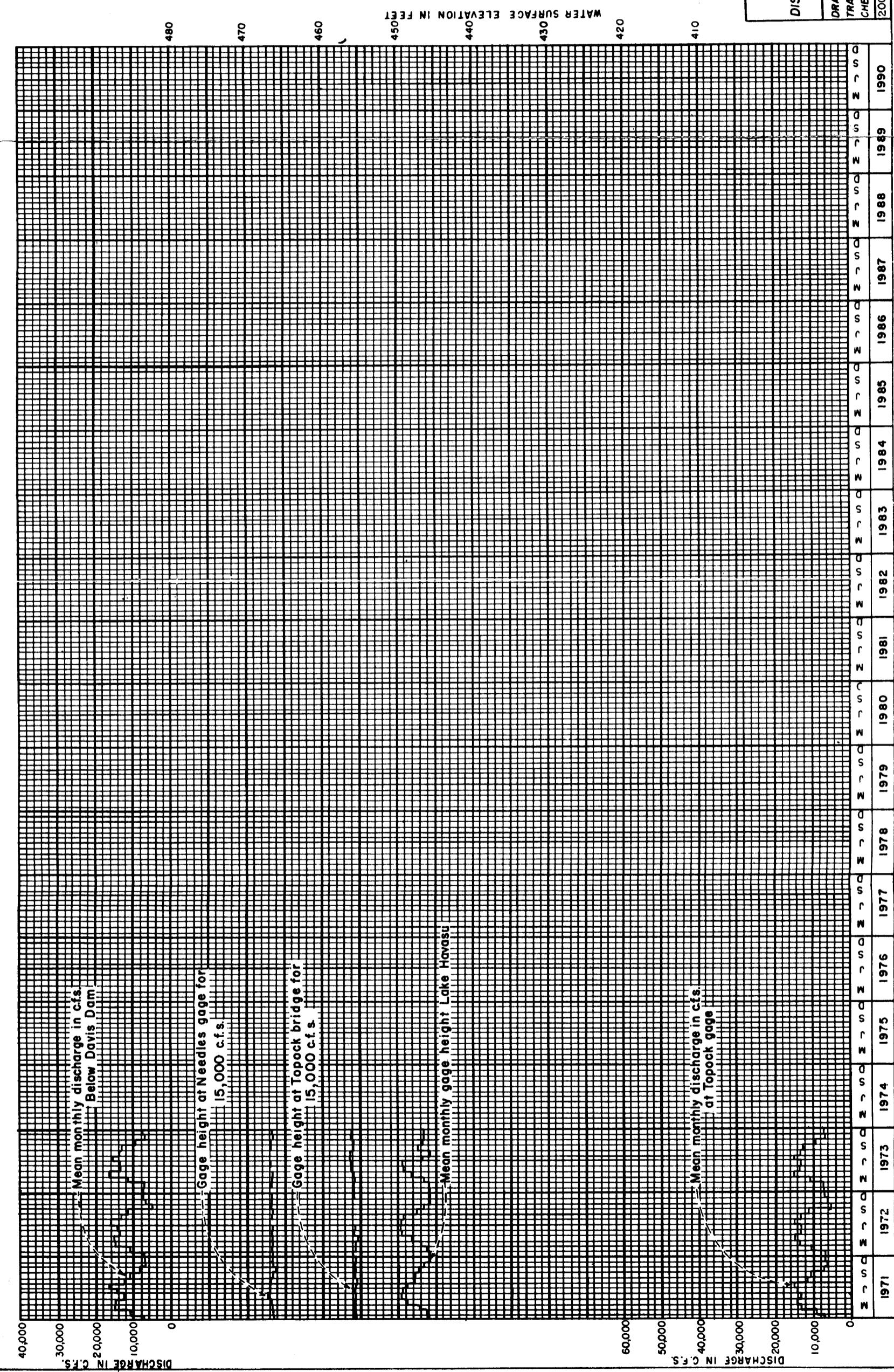
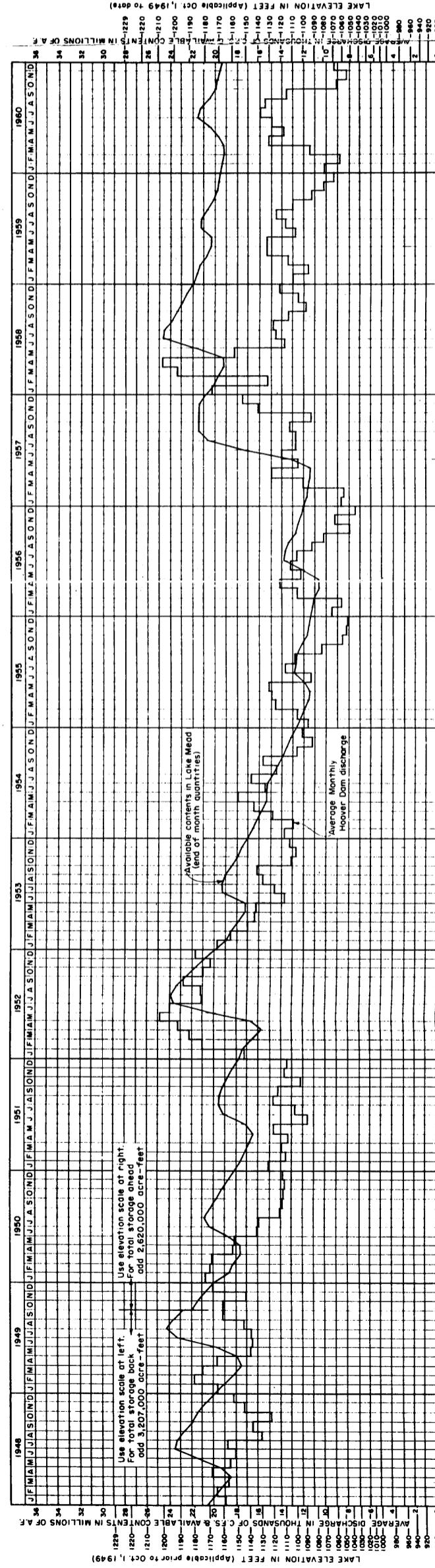
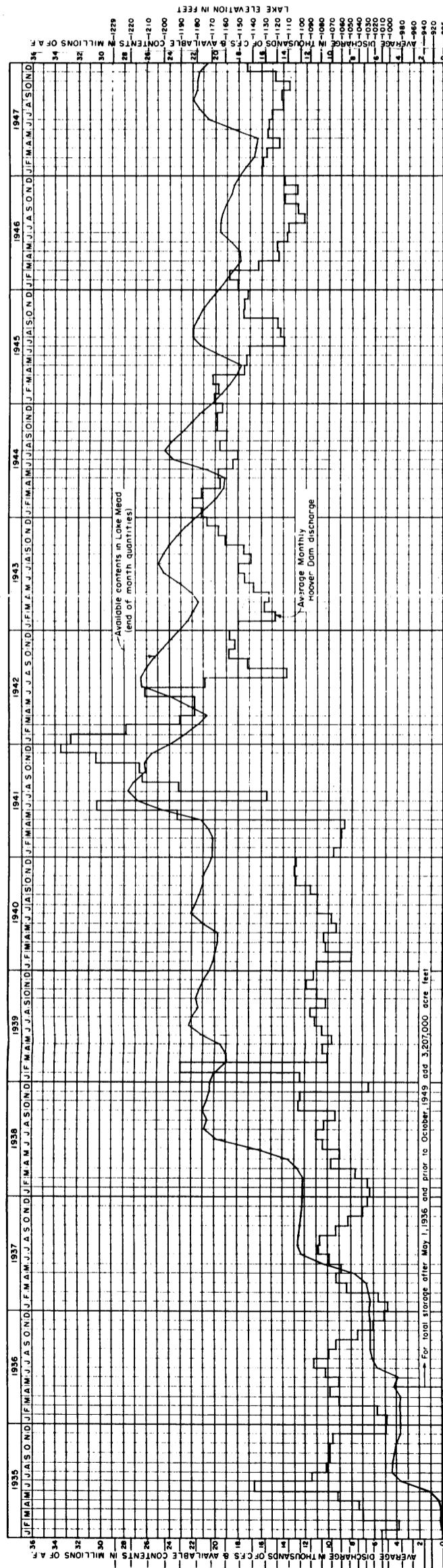


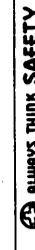
FIGURE 28



NOTES

New capacity table based on sediment surveys of 1948-49 put into use October 1, 1949.

For total storage between May 1, 1936 and October 1949 add 3,207,000 A.F. to available contents. For total contents after October 1949 add 2,620,000 A.F.



ALWAYS THINK SAFETY

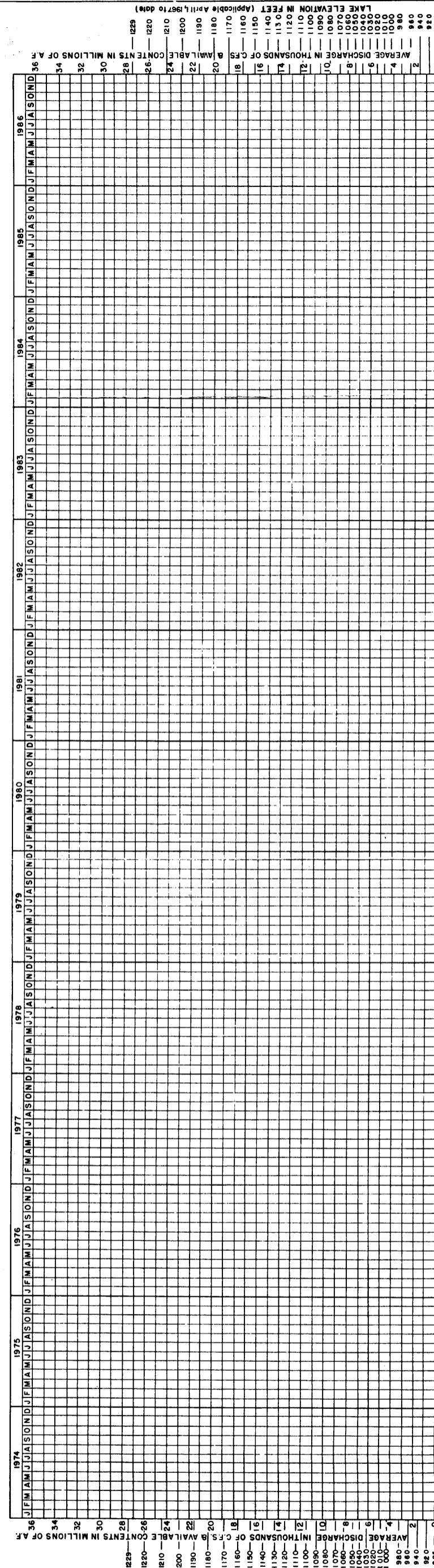
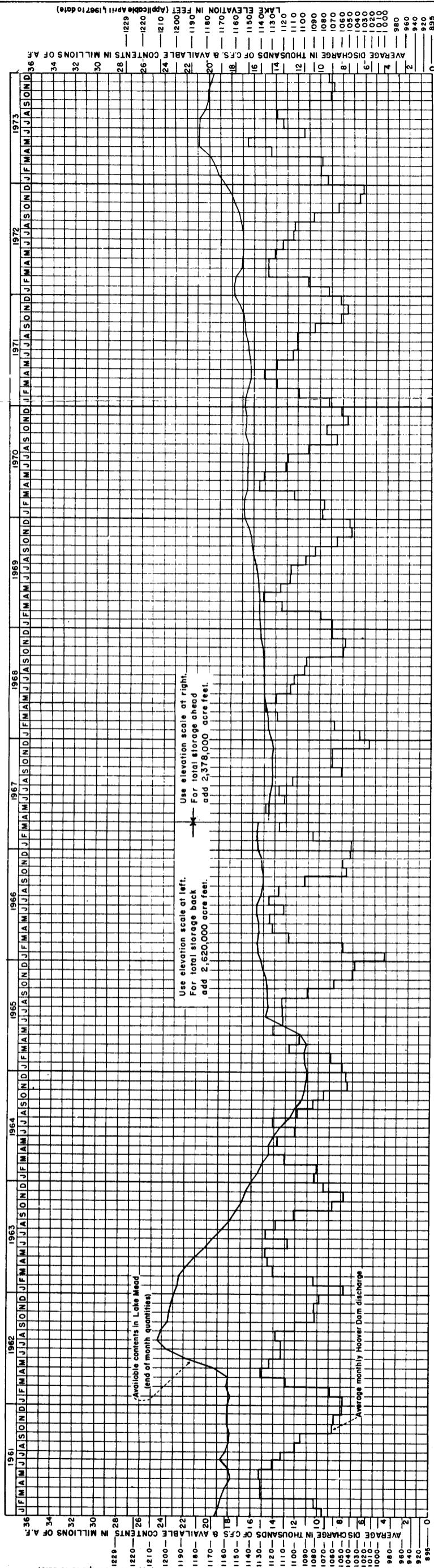
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

RIVER OPERATION DATA
HYDROGRAPHS

HOOVER DAM AND LAKE MEAD
COLORADO RIVER

DRAWN - H.C. - SUBMITTED - D.E. - APPROVED -
TRACED - P.E. - ACCURATE NO DOUBT -
CHECKED - P.E. - APPROVED -
REVIEWED - C.G. - APPROVED -
Boulder City, Nevada
July 5, 1959
Sheet 1 of 2
45-300-90A

FIGURE 28 CONTINUED



NOTES

Data shown hereon were obtained from water supply papers published by the Geological Survey for the period prior to October, 1968. Data since that time were obtained from provisional records of the Geological Survey and are subject to revision.

New capacity table based on sediment surveys of 1948-49 and 1963-64 were put into use October 1, 1949 and April 1, 1967 respectively.

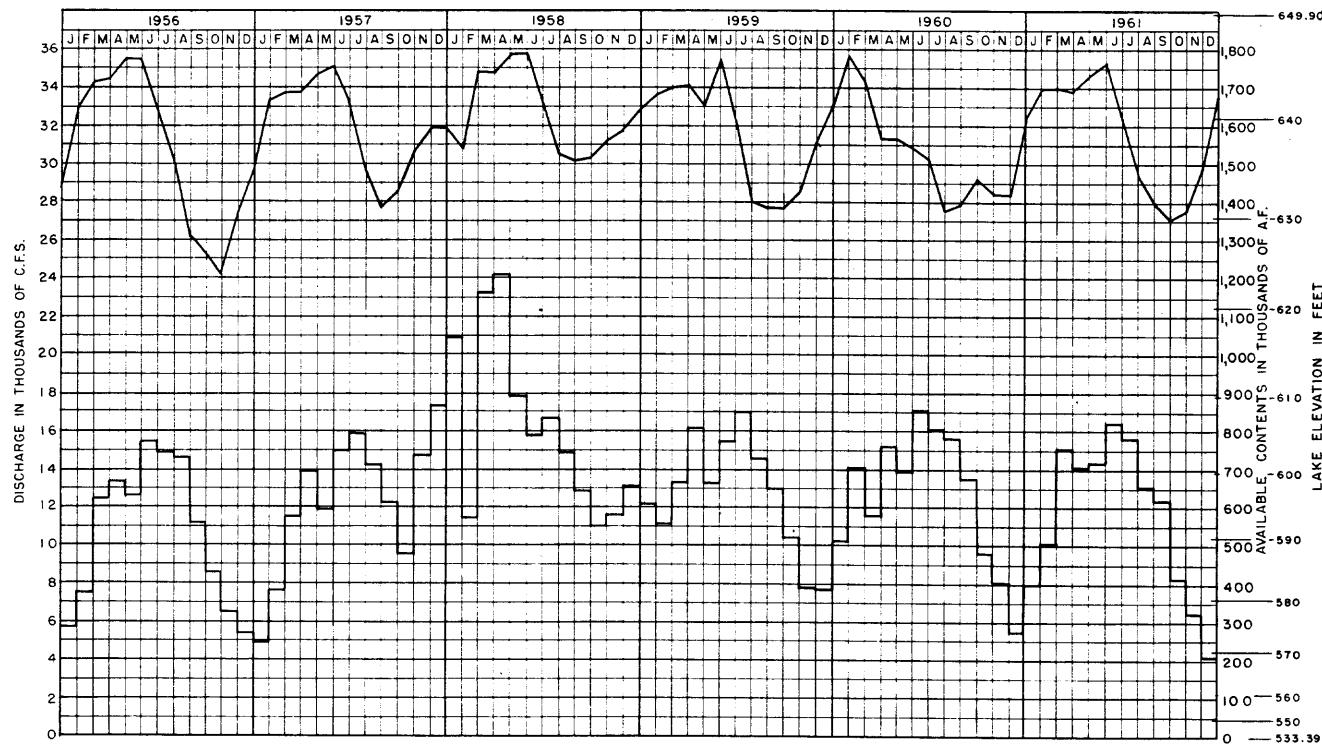
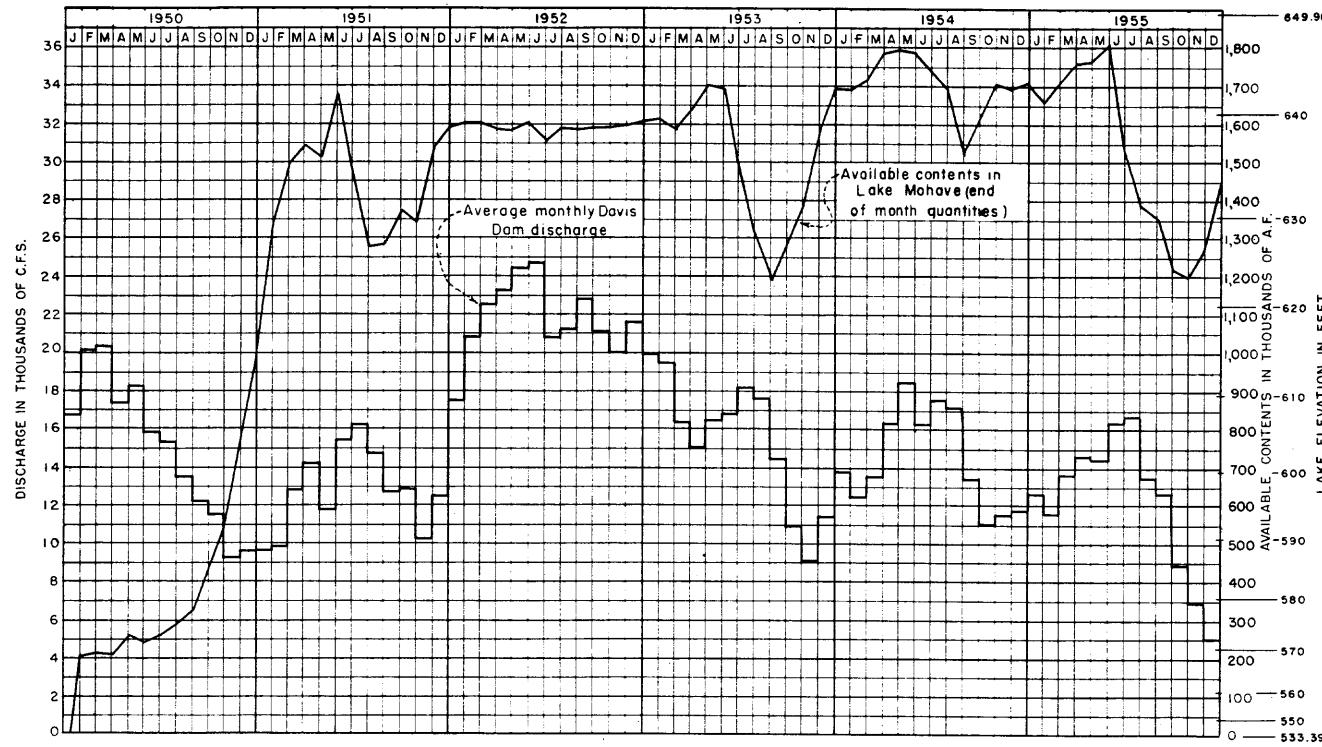
For total storage from May 1, 1936 through September 30, 1949 add 3,207,000 A.F., from October 1, 1949 through March 31, 1967 add 2,620,000 A.F. and from April 1, 1967 add 2,378,000 A.F. to available contents.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 3
RIVER OPERATION DATA
HYDROGRAPHS
HOOVER DAM AND LAKE MEAD
COLORADO RIVER

DRAWN... HMC
TRACED...
CHECKED... HMC
APPROVED... Ray C. L. Schaefer
SUBMITTED... G. E. Bent
RECOMMENDED... G. E. Bent
SHEET 2 OF 2

DATE 5-5-69
45-300-90 B
SHEET 2 OF 2

FIGURE 29

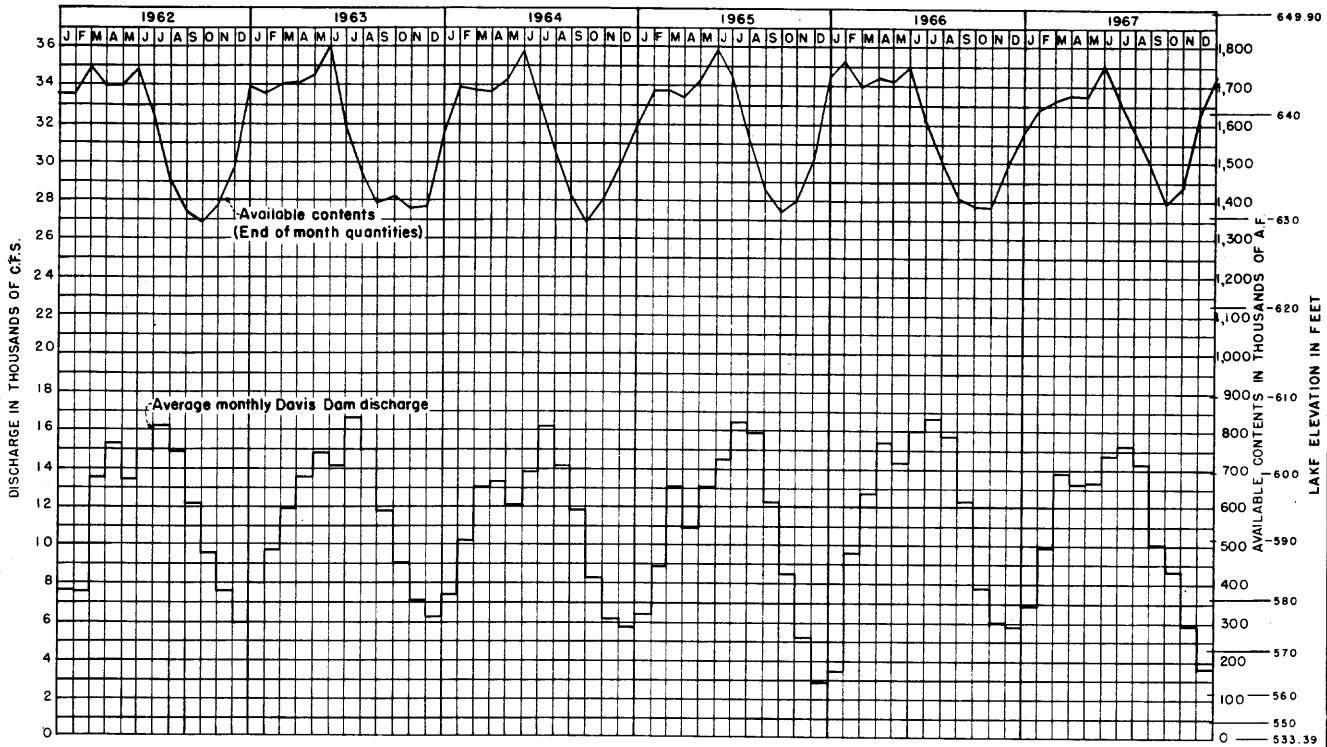


NOTES

Data shown hereon were obtained from water supply papers published by the Geological Survey

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| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 | |
| RIVER OPERATION DATA | |
| HYDROGRAPHS | |
| DAVIS DAM AND LAKE MOHAVE | |
| COLORADO RIVER | |
| DRAWN.....HMC..... | SUBMITTED..... |
| TRACED..... | RECOMMENDED..... |
| CHECKED..... | APPROVED..... |
| BOULDER CITY, NEV SHEET 1 OF 2 351-300-123 A | |
| DATE 5-5-69 | |

FIGURE 29 CONTINUED



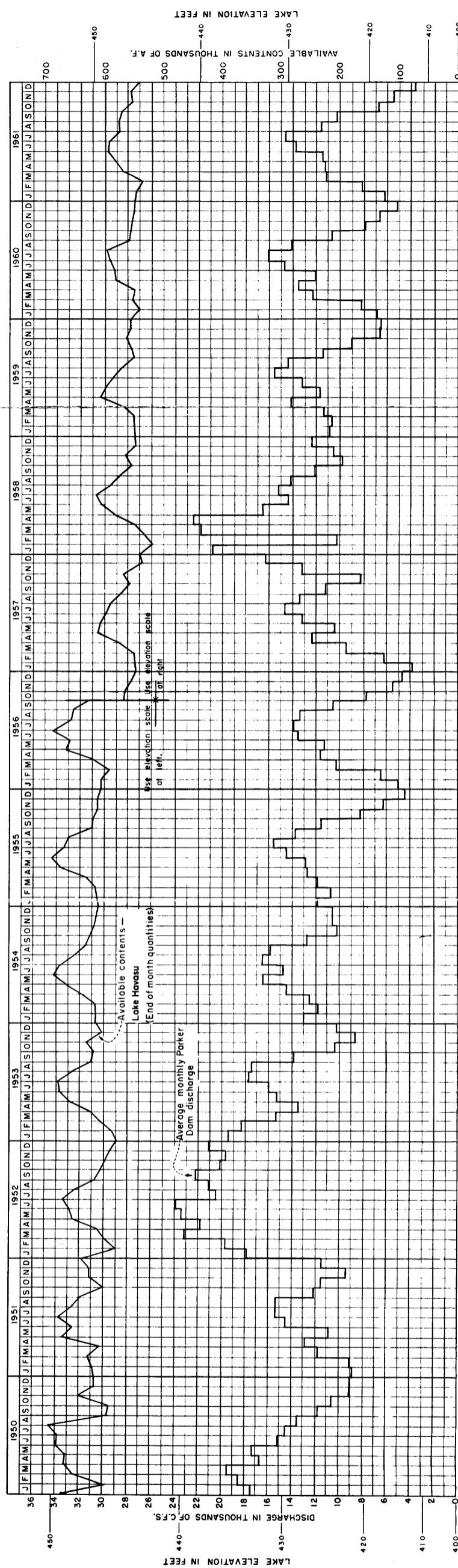
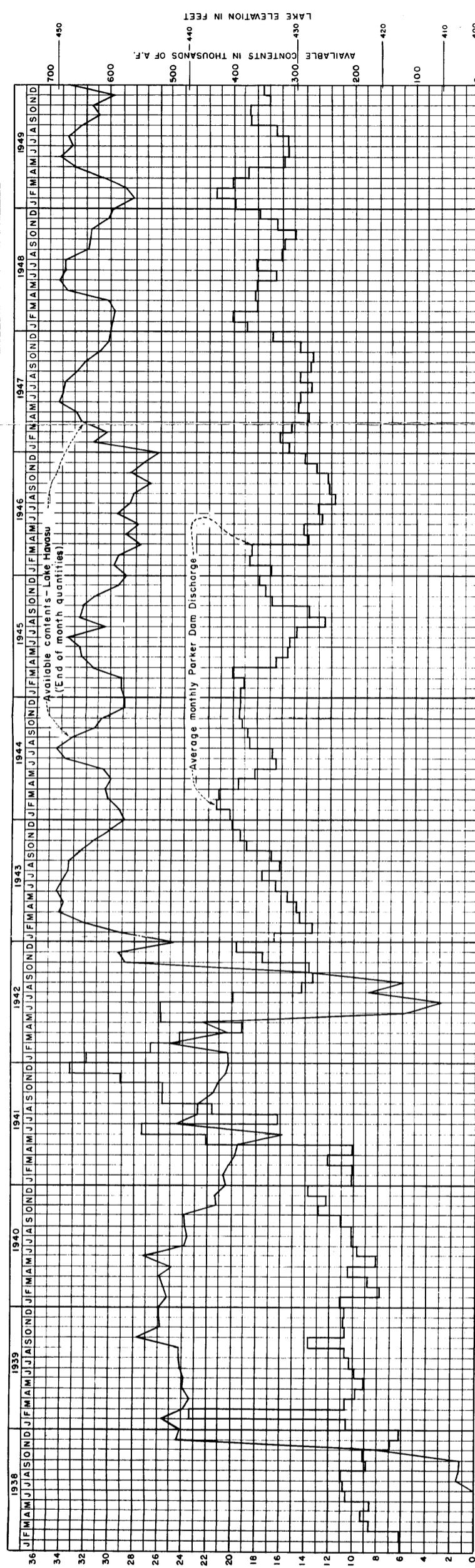
NOTES

Data shown hereon were obtained from water supply papers published by the Geological Survey for the period prior to October 1968.

Data since that time were obtained from provisional records of the Geological Survey and are subject to revision.

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| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 | |
| RIVER OPERATION DATA HYDROGRAPHS DAVIS DAM AND LAKE MOHAVE COLORADO RIVER | |
| DRAWN.....MHC | SUBMITTED..... |
| TRACED..... | RECOMMENDED..... |
| CHECKED.....MHC | APPROVED..... |
| BOULDER CITY, NEV. DATE 5-5-69 | |
| SHEET 2 OF 2 | |
| 351-300-123 B | |

FIGURE 30



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 3

**RIVER OPERATION DATA
HYDROGRAPHS**

PARKER DAM AND LAKE HAVASU
COLORADO RIVER

DRAWN.....HMC
TRACED.....
RECOMMENDED.....
CHECKED.....
APPROVED.....

BOULDER CITY, NEV.
DATE 5-5-69

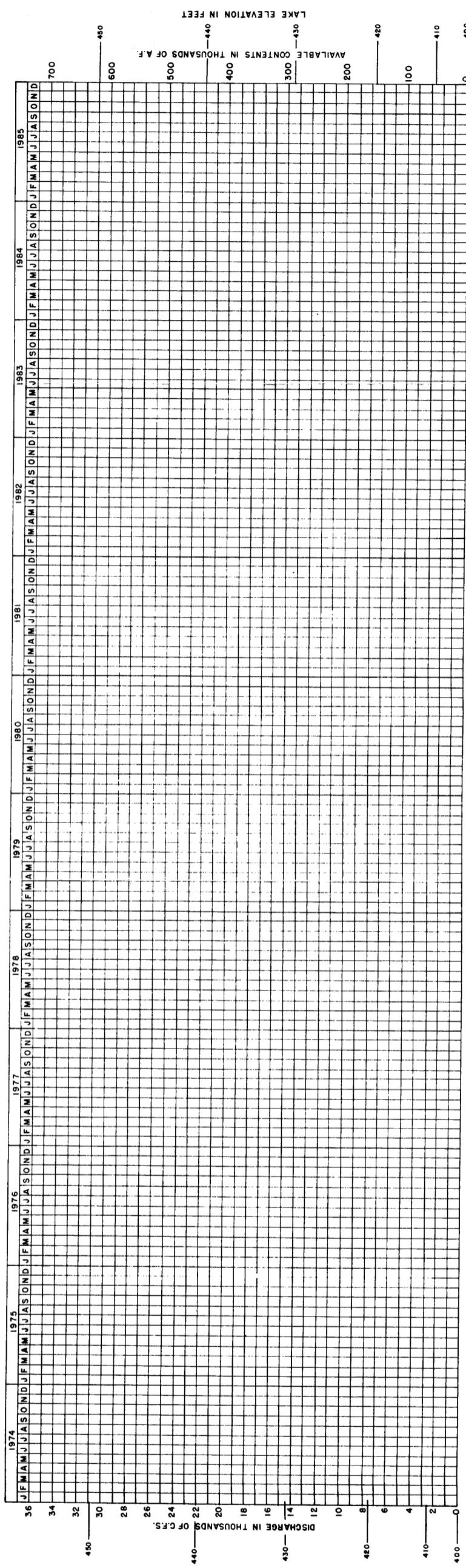
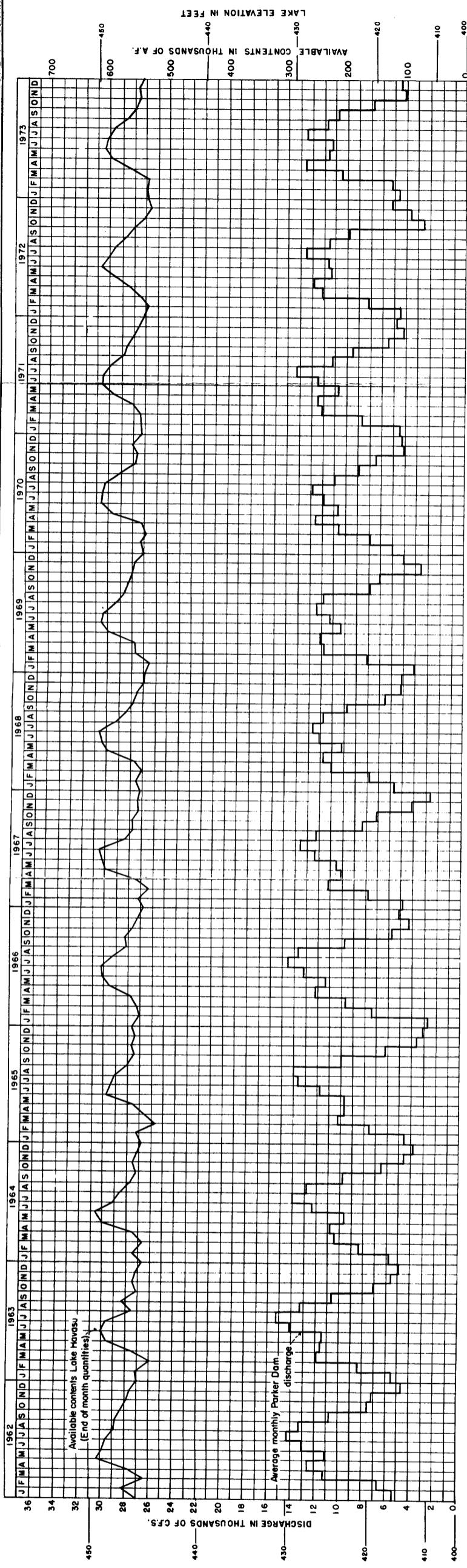
SHEET 1 OF 2

231-300-59 A

NOTES

Data herein were obtained from water supply papers published by the Geological Survey.
Elevations are based on Geological Survey adjustment of 1912.
New capacity table based on sediment survey of April 1957
was placed in use October 1, 1956 for record purposes.

FIGURE 30 CONTINUED

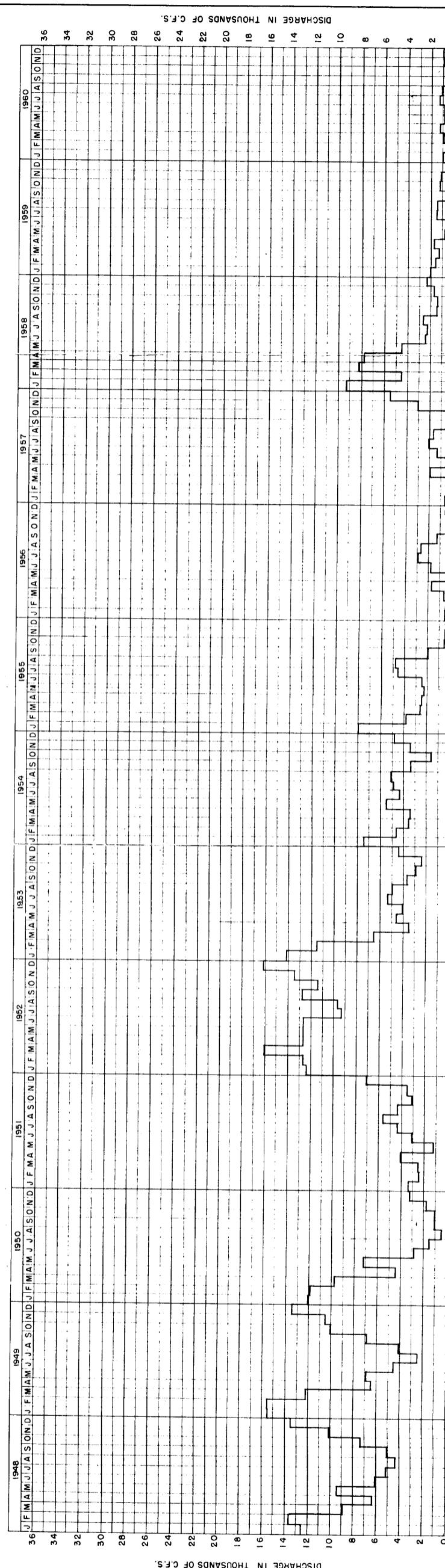
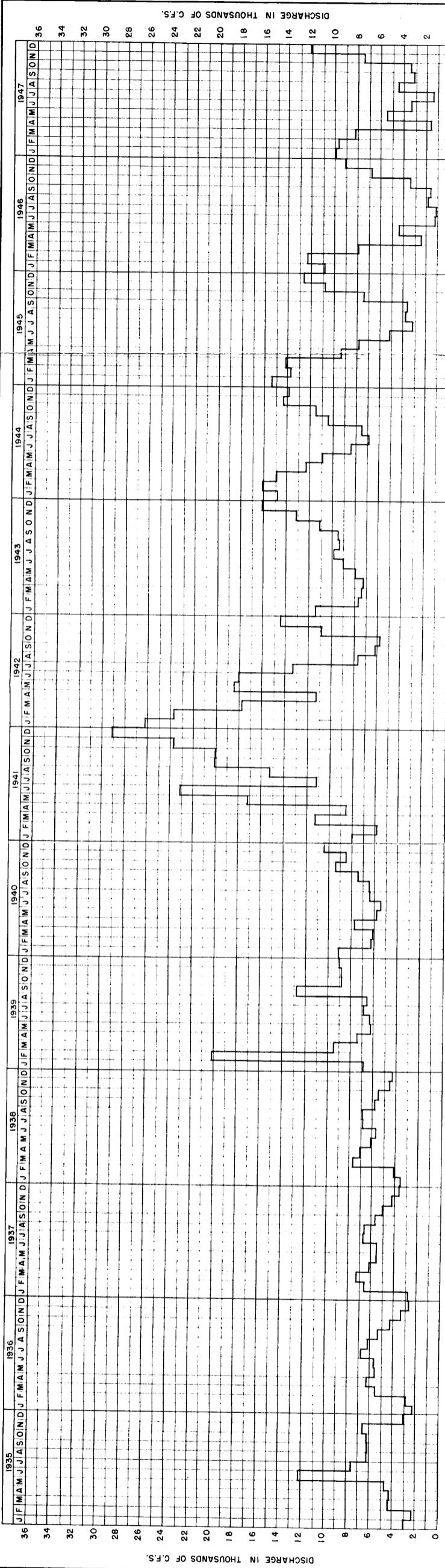


NOTES

Data herein were obtained from water supply papers published by the Geological Survey for the period prior to October 1968. Data since that time were obtained from provisional records of the Geological Survey and are subject to revision. Elevations are based on Geological Survey adjustment of 1912.

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|---|-------------------------------------|
| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 | |
| RIVER OPERATION DATA | |
| HYDROGRAPHS | |
| PARKER DAM AND LAKE HAVASU COLORADO RIVER | |
| DRAWN.....H.M.C. TRACED..... CHECKED..... RECOMMENDED..... APPROVED..... <i>Hand Drawn</i> | SUBMITTED..... <i>Hand Drawn</i> |
| Boulder City, Nev. | DATE 3-1-82 |
| 5-10-74 ADDED 1972 AND 1973 | 300 |
| SHEET 2 OF 2 | |
| 231-300-59 B | |

FIGURE 31



NOTES

Data shown herein are based on records published by the Geological Survey.

RIVER OPERATION DATA
HYDROGRAPHS

COLORADO RIVER NEAR YUMA, ARIZ.

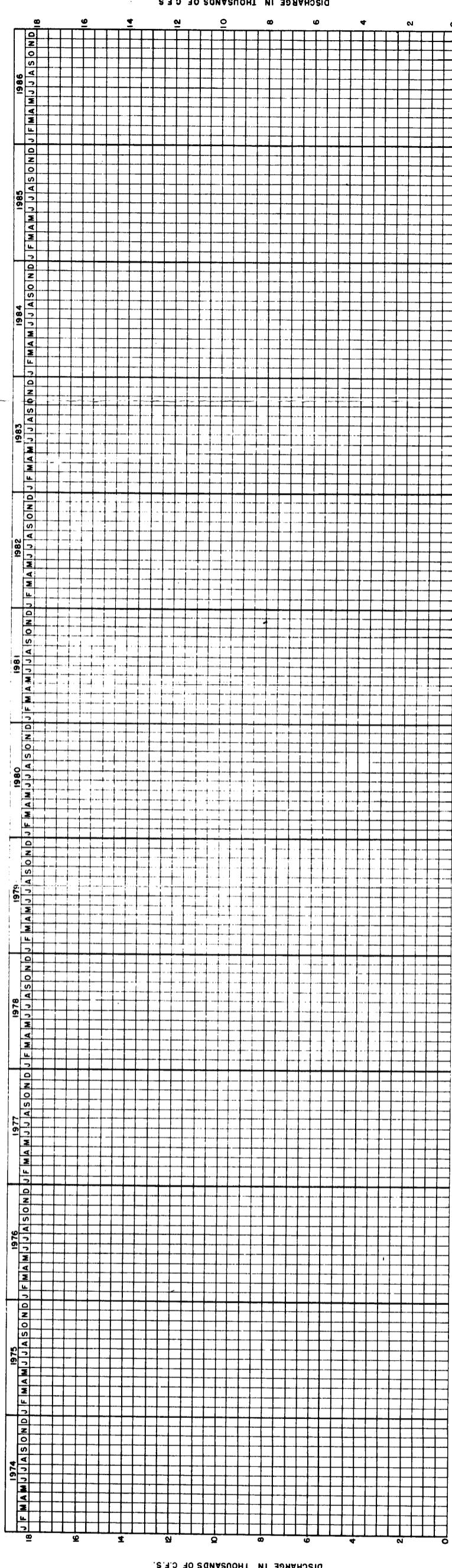
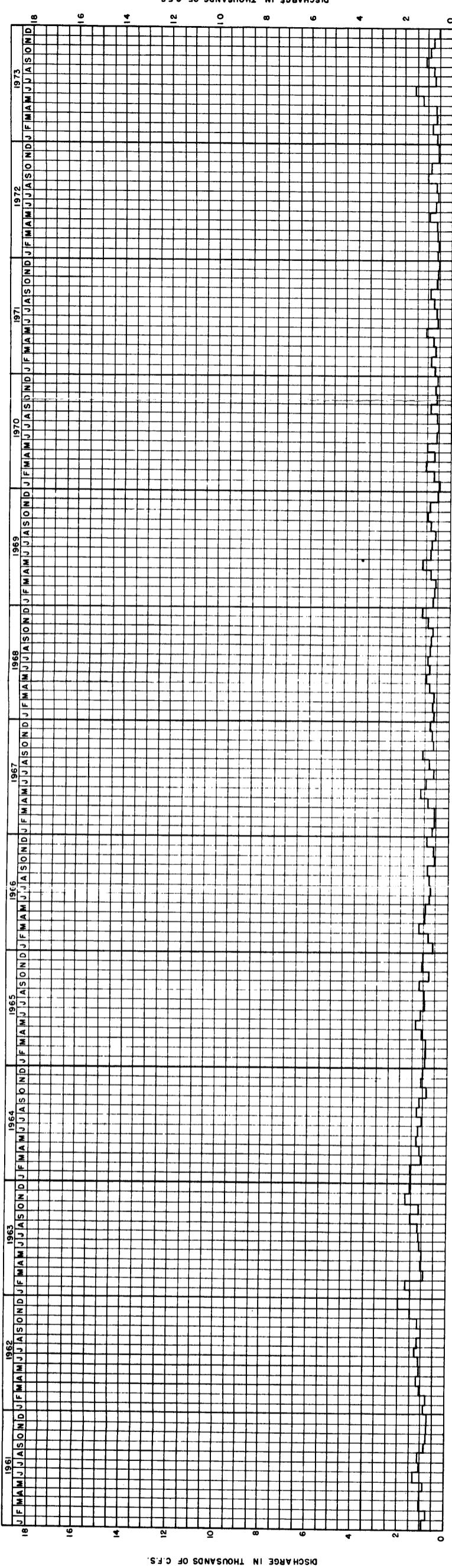
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 3

DRAWN... HMC... SUBMITTED *John C. Scott*
TRACED... HMC... RECOMMENDED *John C. Scott*
CHECKED... HMC... APPROVED *John C. Scott*

BOULDER CITY, NEV SHEET 1 OF 2 DATE 5-18-60

423 - 300 - 91 A

FIGURE 31 CONTINUED



NOTES

Data shown hereon through Sept. 30, 1968 are based on records published by the Geological Survey.
 Data shown after Sept. 30, 1968 are based on Geological Survey provisional records and are subject to revision.
 Data shown after Sept. 30, 1963 are records of flow at station "Colorado River below Yuma Main Canal Wasteway".

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| UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION REGION 3 | RIVER OPERATION DATA |
| HYDROGRAPHS | |
| COLORADO RIVER NEAR YUMA, ARIZ. | |
| SUBMITTED BY <i>John H. Gandy</i> DRAWN..... TRACED..... RECOMMENDED <i>John H. Gandy</i> CHECKED..... APPROVED <i>John H. Gandy</i> | |
| DATE 5-8-74 | ADDED 1972 AND 1973 |
| BOULDER CITY, NEVADA | 423-300-91 B |
| SHEET 2 OF 2 | |

5-10-74
300-

FIGURE 32

